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ABSTRACT

This teaching guide is intended to combine practical experience in the construction industry with the teaching methods of vocational education for instruction in carpentry. Instructional material in this manual is written in terms of student performance, using measurable behavioral objectives. This guide contains 4 sections organized in 24 instructional units. Following a standardized format established in Oklahoma in 1970, the guide includes eight basic components that form a unit of instruction: performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters and supplements, tests, and answers to tests and assignment sheets. (Depending on the specific objectives, not all of these elements may be included in each of the units.) The following topics are included in this course: forming, framing, finishing, and miscellaneous tasks (rigging, welding). (KC)

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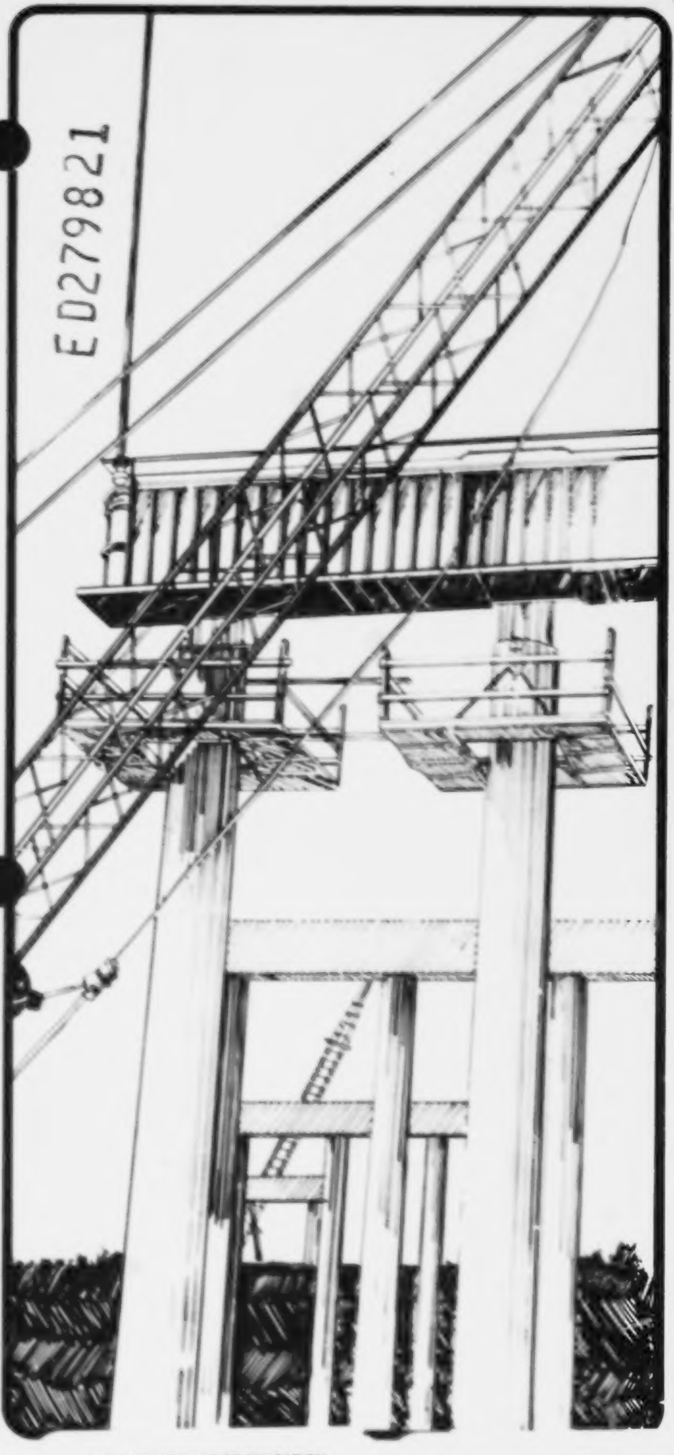

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

AGC

OKLAHOMA STATE BOARD OF VOCATIONAL AND TECHNICAL EDUCATION

commercial carpentry

instructor edition

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Commercial Carpentry

Written by
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Developed as a Cooperative Project by
The Associated General Contractors of America
H. Pratt Farnsworth, Jr., Chairman, Manpower and Training Committee
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Oklahoma State Board of Vocational and Technical Education
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COMMERCIAL CARPENTRY

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FOREWORD

In 1972, The Associated General Contractors of America (AGC) met with representatives of the Oklahoma Curriculum and Instructional Materials Center (CIMC) to discuss the possibilities of developing, as a cooperative project, a course of instruction designed for training carpenters who will make their careers in construction.

This publication is the result of those original discussions and the product of close coordination among general contractors, carpenters, people who actually work in construction, and vocational educators. This manual represents a conscious effort to meld the practical experience of personnel in the construction industry with the best instructional methods of those in the field of vocational education.

The trainers of skilled construction workers are faced with the challenge of providing thorough and modern training to the backbone of the construction industry, its work force. The purpose of this manual is to assist instructors in providing a high-caliber instructional program. In 1978, and again in 1983, AGC and CIMC decided that there was a need to update this manual in order to keep up with the ever-changing materials, skills, techniques, and demands of the profession. Therefore, we have revised this manual with these changes in mind. Although the format reflects a systematic approach to instructional materials development and the latest in educational technology innovations, the information in *Commercial Carpentry* should be adapted and modified to coincide with local conditions. To make the training process complete, the materials should be coupled with the instructor's own methods, experience, and additional materials.

Roy Peters, Director
Oklahoma State Department of
Vocational and Technical Education

H. Pratt Farnsworth, Jr., Chairman
Manpower and Training Committee
The Associated General Contractors
of America

PREFACE

For many years contractors and those responsible for training carpenters felt the need for instructional materials to be used in training. In 1974, The Associated General Contractors of America (AGC), with the cooperation and support of the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center (CIMC), accepted the challenge and produced a manual for use in training carpenters in those areas in which they are expected to be proficient. In 1978, and again in 1983, AGC and the CIMC decided that there was a need to update this manual in order to keep up with the ever-changing materials, skills, and demands of the profession.

Carpentry instructors are faced with the challenge of providing students with the skill and related information necessary to meet the demands of a changing profession. Competition for jobs is greater than ever. Therefore, the carpenter must be better trained and better equipped to find and retain meaningful employment. This is why AGC and CIMC felt a need to revise and update this manual.

Instructional material in this manual is written in terms of student performance, using measurable behavioral objectives. This is an innovative approach to teaching that accents and augments the teaching/learning process. Criterion-referenced evaluation instruments provide for a uniform measurement of student progress.

The purpose of this manual is to assist carpentry instructors in providing instruction throughout the industry. This publication should be supplemented by each instructor's methods and materials. Any information in this manual that does not concur with the instructor's course of study should be modified to meet personal needs.

Bob Patton, Coordinator
Curriculum and Instructional
Materials Center

ACKNOWLEDGEMENTS

Appreciation is expressed to the many individuals who contributed their time, talents, and knowledge in the preparation of the revision of this manual.

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USE OF THIS PUBLICATION

Instructional Units

Commercial Carpentry contains four sections and twenty-four instructional units. A standard format was established in 1970 for development of instructional materials for all Oklahoma vocational teachers. This format includes eight basic components that form a unit of instruction: performance objectives, suggested activities for the teacher, information sheets, assignment sheets, job sheets, transparency masters and supplements, tests, and answers to tests and assignment sheets. Depending on the specific objectives, there may or may not be transparency masters, supplements, student supplements, assignment sheets, or job sheets included in the unit of instruction.

All of the unit components "zero in" on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help him or her determine the following

- Amount of material that can be covered in each class period
- Skills that must be demonstrated
  Supplies and equipment needed
  Amount of practice needed
  Amount of class time needed for demonstrations
- Supplementary materials, such as pamphlets and filmstrips, that must be ordered
- Resource people to contact

Performance Objectives (white pages)

Each unit of instruction is based on the performance needed for successful employment in an occupational area. Performance objectives are stated in two forms: unit objectives, stating the subject matter to be covered in a unit of instruction; and specific objectives, stating the performance necessary to reach the unit objective. Since the objectives of the unit provide direction for the teaching/learning process, it is important that teachers and students have a common understanding of the intent of the objectives.

The objective sheet should be given to students and referred to throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Prepare for each unit by deciding how each objective can best be taught.

The objective sheet may also be used as a quick pretest to determine students' prior knowledge and to determine whether further study or activities are necessary. Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When changes in objectives are made, the teacher should remember to supply the needed information, assignment and/or job sheets, and criterion test items.

I am also thankful to the many people involved in the production process. Writing assistance and editorial guidance were provided by Robert Hilley, CIMC Development Specialist. Thanks to those in the Communications Center, under Debbie Hixson, who prepared the many drafts of this manual, with special thanks to Rose Primeaux, Stephanie Shipley, and Lisa Tomlinson.

The illustrations for this publication came from a number of sources. We are thankful to the many companies and publishers who contributed artwork, identified by the permission lines accompanying many of the illustrations. We are also grateful for the splendid work done by the Art Department, under Bob Davis, and especially to Gary Bradley, Kim Hale, Kathryn Hansen, Robert Randall, and Scott Stone, who served as illustrators on this project.

The quality of the published product is the result of the care and talents of the Print Shop personnel under the supervision of Noel Wilcoxson. None of this would have been possible without the dedication and skills of the CIMC secretarial staff under Judy DeVaughan, and especially the assistance of Janette Nicholson, secretary to the Development Unit. To these and many others, I am extremely grateful to have shared in this team effort.

It is my sincere hope that these materials will be of value to carpentry instructors and that they benefit those students who pursue careers in this vital and rewarding field.

Bud Hendrix

Suggested Activities and Supplements (pink pages)

Suggested activities are included only in teacher materials. The suggested activities pages include an outline of the unit contents and an instructor's guide designed to assist teachers in planning their presentation of the unit. The instructor's guide provides suggestions for delivery and/or presentation during the instructional process. Read the suggested activities before teaching the units so that supplemental materials can be obtained, audiovisual materials prepared, and outside resources contacted. Duties of the teacher will vary according to the particular unit.

The references that are listed in the suggested activities are ones used in the development of each unit. They may be used by the teacher to supplement her or his knowledge of the subject area or to help students with particular interests or occupational objectives in the area covered.

The suggested activities section of the unit also includes supplements and transparency masters. Each of these components provides information in a special way. Supplements may consist of motivational materials, review, or practice materials such as charts and reference materials. Supplements are designed to be copied and distributed to individual class members or to the class as a whole. Suggestions for their use are included in the instructor's guide. Transparencies direct the class' attention to the topic of discussion. Transparencies may present new information, or they may reinforce information presented in the information sheet. They are particularly effective when identification or analysis is necessary. Order transparencies from the Curriculum and Instructional Materials Center, or from the Associated General Contractors of America, or make transparencies and place them in the notebook where they will be immediately available for use.

Information Sheet (green pages)

The information sheet provides "must know" content essential for meeting the cognitive (knowledge level) objectives of the unit. The information is written in a topical-outline form and is keyed to the specific objectives.

Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. The information sheet may also be used for coordination activities and advisory committees.

Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide motivation for each unit.

Student Supplements (white pages)

Student supplements consist of charts or reference materials that are made available to each class member. Students may use them to complete assignment or job sheets or keep them for future reference.

Assignment Sheets (brown pages)

Assignment sheets give students a chance at problem solving, self-assessment, and/or practical experience. They assist students in the application of knowledges that are necessary prerequisites to skill development. Assignment sheets may be given to the student for completion in class or may be used for homework assignments. Answer sheets are provided when appropriate and can be used by the student and/or teacher for checking student progress. The scores of those assignment sheets listed in the specific objectives should be averaged with the unit test score, as the skills addressed in these assignment sheets are considered necessary in meeting the unit objective.

Job Sheets (blue pages)

Job sheets are another important segment of a unit of instruction. The job sheets provide a list of equipment, tools, and materials needed to complete a manipulative or psychomotor skill. They describe a step-by-step procedure needed to complete each task or job. Diagrams, photographs, and illustrations are provided to assist students in achieving the skill.

The teacher should demonstrate to students the procedures outlined in each job sheet. Furthermore, the teacher needs to localize the job sheet according to the equipment and supplies available in the local lab or shop situation. Job sheets also furnish potential employers with a picture of the skills being taught and the performances they might reasonably expect from a person who has had this vocational instruction.

Job sheet performance should be evaluated by the instructor and averaged with the unit test score, as the skills addressed in the job sheets are considered necessary in meeting the unit objective.

Tests (yellow pages)

The test provides criterion-referenced evaluation of every objective listed in the unit of instruction. It is crucial to note that both paper/pencil and performance objectives must be evaluated.

It is recommended that the tests be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of questions from the units covered may be used for final tests at the end of each term if desired. If objectives have been added, deleted, or modified, be sure to make the changes on the test.

The acceptable response on a unit test, 85 percent in most units, may be raised or lowered to fit the topic or students' ability levels. The percentage applies to the overall score, not to each question. The final unit grade should be obtained by using the paper/pencil score and evaluations of student demonstrations of the desired skills.

Answers to Test and Assignment Sheets (pink pages)

Answers to test and assignment sheets are components designed to assist the teacher in evaluation of student performances.

Page Numbering

Each publication from the Curriculum and Instructional Materials Center (CIMC) is assigned a specific abbreviation. For example, *Commercial Carpentry* has been abbreviated CC. The units are then numbered consecutively within each section. An example of a page number is CC-1-A. Since CIMC publications are loose leaf, this system of page numbering was adopted so that pages from different manuals would not get mixed up.

Methods of Disseminating Material

Material may be given out a unit or page at a time to keep the material before the student always new. Some teachers ask students to furnish a three-ring binder for the units. This is convenient for taking the materials home to study. Upon completion, each unit is then placed in a larger binder. The large binders may be purchased at cost from the CIMC. Some teachers store the materials by units in filing cabinets or boxes until needed. All the units may be given out at once if desired.

For best results, provide student materials for each student. Student materials contain everything but the test answers, answers to assignment sheets, and suggested activities. All tests are collated at the back of student material and should be removed and stored until needed.

Teaching Methods

It is a challenge to keep students motivated. Supplement the objectives by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each objective can best be taught. Allow students to become involved in preparing and planning.

Competency Profiles

Competency profiles are folders used to document student performance. The profile contains a list of the specific job competencies that a student should achieve prior to leaving the training program. Competency profiles may be ordered from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, and from The Associated General Contractors of America, 1957 E. Street N.W., Washington, D.C. 20006.

CORRECTIONS AND SUGGESTIONS

The Curriculum and Instructional Materials Center (CIMC) wants to provide vocational instructors and students with materials that are accurate and effective. Although the CIMC strives to maintain the highest standards of development and production, oversights occasionally do occur. If you find any errors in this or other CIMC publications, or have suggestions for improving their usefulness in vocational programs, please notify the CIMC staff. One easy way of pointing out errors is to make a photocopy of the affected page and to indicate the correction on the copy. You can mail the information to the CIMC, where it will be used to correct the publication before the materials are reprinted.

To ensure that the material is updated on a timely basis, it is important that you notify the CIMC of necessary corrections as soon as possible after discovering the error. Do not assume that someone else will notice the error and inform the CIMC; other users may be making the same assumption. Please send corrections and recommendations for improving this publication to the following address:

Assistant Coordinator for Development
Curriculum and Instructional Materials Center
Oklahoma State Department of Vocational and
Technical Education
1500 West Seventh Avenue
Stillwater, Oklahoma 74074

INTRODUCTION TO FORMING
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to explain the purpose of forms, identify parts of forms, and name hardware used on forms. The student should also become familiar with some of the duties of the carpenter and should be able to make slump test and cylinder cast. The student will show this knowledge by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with forming.
2. Explain the purpose of forms.
3. Name types of forms.
4. Match external factors that affect form design to their effects.
5. Identify parts of a form.
6. Name types of hardware used on forms.
7. Demonstrate the ability to
    a. Make a slump test.
    b. Make a cylinder cast.

INTRODUCTION TO FORMING
UNIT I

SUGGESTED ACTIVITIES

I. Unit contents
   A. Objective sheet
   B. Suggested activities
      1. Supplements
         a. Supplement #1 — Carpentry Duties Associated with Concrete
         b. Supplement #2 — Types of Cement and Concrete Strengths
         c. Supplement #3 — Functions of Types of Admixtures
         d. Supplement #4 — Types and Sizes of Reinforcing Used in Concrete
         e. Supplement #5 — Purposes of Concrete Tests
         f. Supplement #6 — Purposes of Types of Concrete Joints
         g. Supplement #7 — Estimating Concrete
      2. Transparency masters
         a. TM #1 — Parts of a Form
         b. TM #2 — Standard Sizes of Welded Wire Mesh
         c. TM #3 — Sizes of Reinforcing Bars
         d. TM #4 — Types of Concrete Tests
         e. TM #5 — Types of Concrete Tests (Continued)
         f. TM #6 — Types of Concrete Tests (Continued)
         g. TM #7 — Types of Concrete Tests (Continued)
         h. TM #8 — Types of Joints
         i. TM #9 — Types of Joints (Continued)
         j. TM #10 — Types of Joints (Continued)
         k. TM #11 — Concrete Calculator
         l. TM #12 — Concrete Estimating Table

SUGGESTED ACTIVITIES

- C. Information sheet
- D. Job sheets
  1. Job Sheet #1 — Make a Slump Test
  2. Job Sheet #2 — Make a Cylinder Cast
- E. Test
- F. Answers to test

II. Instructor's guide

- A. Review unit and plan presentation.
- B. Order or obtain materials to supplement unit.
  1. Materials and equipment necessary for job sheet completion
  2. Resource materials

     (NOTE: Use latest copies)

     a. Wagner, Willis H., *Modern Carpentry,* The Goodheart-Willcox Company, Inc., 123 West Taft Drive, South Holland, Illinois 60473

     b. Lewis Gasper, J. *Carpentry,* Delmar Publishers Inc., 2 Computer Drive West, Box 15-015, Albany, New York 12212
  3. Transparencies and competency profiles

     (NOTE: Transparencies and competency profiles are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)
- C. Introduce unit to students.

  SUGGESTIONS:

  - Stress the importance of good, solid forms.
  - Explain the differences among forms and give reasons for using one particular form over another.
  - Use Supplement #1 to emphasize carpentry duties associated with concrete work.

SUGGESTED ACTIVITIES

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

   1. Use Information Sheet, Section I to introduce students to the terms and definitions associated with forming

      SUGGESTION:

      - Show students examples of appropriate terms.

   2. Use Information Sheet, Section II to explain the purpose of forms.

   3. Use Information Sheet, Section III to discuss types of forms.

      SUGGESTIONS:

      - Exhibit examples or pictures of the various types of forms.
      - Visit a construction site where various types of forms are in use.
      - Relate types of forms to specific purposes.

   4. Use Information Sheet, Section IV to discuss external factors that affect form design.

      SUGGESTIONS:

      - Use Supplements 2, 3, 5, and 6 and Transparencies 5, 6, and 7 to expand your discussion.
      - Demonstrate Job Sheets 1 and 2 and show students various admixtures.
      - Allow students to practice procedures.

   5. Use Information Sheet, Section V to discuss parts of a form.

      SUGGESTIONS:

      - Use Transparency 1 to illustrate parts of a form; use Transparencies 2 and 3 and Supplement 4 to discuss reinforcing.
      - Use Supplement 6 and Transparencies 8, 9, and 10 to discuss concrete joints, relating joints to form construction.

        (NOTE: Depending on local practices and training objectives, you may want to discuss estimating concrete. Supplement 7 and Transparencies 11 and 12 will provide you with useful aids.)

SUGGESTED ACTIVITIES

6. Use Information Sheet, Section VI to discuss types of hardware used on forms.

   SUGGESTIONS:

   - Provide the class with examples of each type of hardware, emphasizing those used in your area.
   - Explain the advantages and disadvantages and the specific purposes of each type.

H. Give test.

I. Critique test and discuss results.

J. Reteach and retest if necessary.

K. Complete appropriate sections of competency profiles.

III. Unit references

A. Hendrix, Laborn J. "Bud", *Cement Masons Curriculum.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America. 1975.

B. Hendrix, Laborn J. "Bud", *Commercial Carpentry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America. 1979.

C. Hendrix, Laborn J. "Bud", *Construction Craftsman Curriculum.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America. 1978.

D. Maxwell Supply Catalog #00151 Tulsa, Oklahoma: Maxwell Supply of Tulsa, 1800 North Sheridan, Tulsa, OK 74115. 1983.

E. Wagner, Willis H. *Modern Carpentry.* South Holland, Illinois: The Goodheart-Willcox Co., Inc. 1976.

SUGGESTED ACTIVITIES
SUPPLEMENT #1 — JOBS OR DUTIES OF THE CARPENTER

Since carpenters usually lay out the building lines, supervise the excavation, build the forms, and supervise the construction they need a working knowledge of standards and practices,not only in lumber but in concrete. They should have an understanding of the characteristics and handling of concrete. They should know the different types of cement, strengths, admixtures and reinforcing used in concrete and they should be able to take samples of concrete and make the necessary test. They should also have some knowlege of the types of joints used in in concrete and should be able to estimate concrete.

There are many types of footing form designs and many types of patented forms on the market. Regardless of design or type of form system used or method of erection, certain basic considerations should be followed. Forms must be tight, smooth, free of defects, and properly aligned. Forms must also be strong and properly braced. If the bracing seems inadequate, add more bracing. It is better to overbrace than to lose a form. Various types of manufactured braces, clamps, and ties are available to help the carpenter build strong forms. Forms and accessories can also be purchased from manufacturers, and there are some suppliers that rent or lease forms.

Form design is very important because a good carpenter is economical and reuses the forms. To speed erection and stripping, the carpenter should use form panels whenever possible; and to prevent damage to the panels so that they may be reused, the carpenter should use the minimum number of nails necessary to erect the panels.

After the panels are removed, a little time should be devoted to the maintenance of the forms. Clean the forms thoroughly, make repairs as necessary,coat each form with form oil, stack them neatly, and protect them from the weather.

SUGGESTED ACTIVITIES
SUPPLEMENT #2 — TYPES OF CEMENT AND CONCRETE STRENGTHS

Most common types of portland cement and their uses

Type I — Normal portland cement; general purpose

Type II — Modified portland cement for moderate sulfate resistance, lower heat of hydration; generally used for massive construction

Type III — High-early-strength portland cement; used when high strength at an early age is desired

Type IV — Low heat portland cement; used where rate of heat must be kept at a minimum, intended only in massive construction

Type V — Sulphate resistant portland cement; used only in construction that is exposed to severe sulphate action

White portland cement — Pure white color; generally used for architectural purposes

The most important factor influencing strength of concrete is the water-cement ratio. Concrete strengths are determined by an engineer and are found in the specifications for different concrete projects.

SUGGESTED ACTIVITIES
SUPPLEMENT #3 — FUNCTIONS OF TYPES OF ADMIXTURES

Accelerator — Speeds set of concrete and increases early strength

Air-entraining agent — Incorporates microscopic air bubbles into concrete to improve workability and resistance to freezing, thawing, and scaling

Color pigment — A mineral or synthetic agent used to achieve a desired color in concrete

Pozzolan — Siliceous and aluminas material which in itself possesses little or no cementitious value but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperatures to form compounds possessing cementitious properties which lowers cost, reduces heat of hydration and increases workability of concrete

Retarder — Delays setting time which supplies the workers sufficient time to finish the concrete

Waterproofer — Mixture of compounds that seals the concrete which allows the concrete to cure from within which in turn increases the strength of the concrete

Water reducer — An agent that reduces the amount of mix water but increases the fluidity of concrete which in turn increases workability without decreasing the strength of the concrete

Ice — Ice is sometimes used as part of the mixing water to lower the temperature of concrete during hot weather

SUGGESTED ACTIVITIES
SUPPLEMENT #4 — TYPES AND SIZES OF REINFORCING USED IN CONCRETE

Common sizes of wire mesh reinforcing

(NOTE: Wire mesh reinforcing is usually used on flat concrete work such as floor slabs, pavements, sidewalks and such.)

Rolls
4×4—W4.0 × W4.0
4×4—W2.9 × W2.9
4×4—W2.0 × W2.9
4×4—W1.4 × W1.4
6×6—W4.0 × W4.0
6×6—W2.9 × W2.9
6×6—W2.0 × W2.0
6×6—W1.4 × W1.4

Sheets
4×4—W5.5 × W5.5
4×4—W4.0 × W4.0
6×6—W5.5 × W5.5
6×6—W4.0 × W4.0
6×6—W2.9 × W2.9

Common sizes of reinforcing bars, or rebars

(NOTE: Rebars are deformed steel bars of various sizes used to reinforce concrete which must sustain bending, stretching, or twisting force in load-bearing concrete. Size of rods used depends on tensile force the concrete will carry. Size, location, and spacing is determined by an engineer and is specified.)

#2 — ¼" rod diameter
(smooth rod)

#3 — ⅜" rod diameter

#4 — ½" rod diameter

#5 — ⅝" rod diameter

#6 — ¾" rod diameter

#7 — ⅞" rod diameter

#8 — 1" rod diameter

#9 — 1-⅛" rod diameter

#10 — 1-¼" rod diameter

#11 — 1-⅜" rod diameter

#14 — 1-¾" rod diameter

#18 — 2-¼" rod diameter

(NOTE: Minimum concrete coverage over rebars is very important and should be rigidly maintained. Amount of concrete coverage is determined by an engineer and is indicated on drawings or specifications.)

SUGGESTED ACTIVITIES
SUPPLEMENT #5 — PURPOSES OF TYPES OF CONCRETE TESTS

Slump test — Determines the consistency of fresh concrete

Cylinder or Compression test — Checks adequacy of mix proportions for compressive strength

Flexural test — Checks adequacy of mix proportions for flexural strength

Air test — Determines the amount of air in the fresh concrete

Temperature — Checks the temperature of fresh concrete

Ball penetraton — Determines consistency of fresh concrete

Impact test — Determines approximate strength of hardened concrete

Core test — Determines strength of hardened concrete

SUGGESTED ACTIVITIES
SUPPLEMENT #6 — PURPOSES OF TYPES OF JOINTS USED IN CONCRETE

Control joint — Joint used to induce cracking at a particular point rather than at random; also to control transverse and longitudinal cracking, control slab movement and to divide the concrete into suitable spacings.

Construction joint — Joint where pour is temporarily suspended

Decorative joint — Creates decorative patterns or designs

Expansion or Isolation joint — Joint used to isolate one section of concrete from another or to cut around rigid objects

- Tooled isolation joint with capped steel rod
- Tooled isolation joint held down for sealant
- Sawed control joint
- Tooled control joint
- Tooled construction joint with keyway
- Tooled construction joint with steel dowels
- Tooled construction joint with expansion
- Tooled dummy joint
- Open joint for filling
- Finger expansion joint
- Sliding plate expansion joint
- Water stops and others

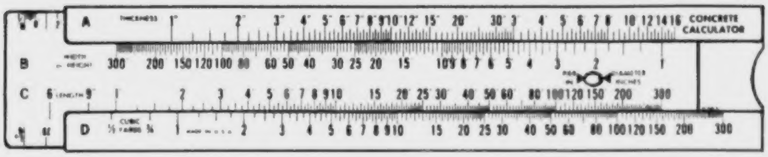
SUGGESTED ACTIVITIES
SUPPLEMENT #7 — ESTIMATING CONCRETE

Using concrete calculator (Furnish students with calculator)

1. Select desired thickness on Scale A
2. Select desired width or height on scale B
3. Align scale A with scale B
4. Select desired length on scale C
5. Find the amount of concrete indicated on scale D where it aligns with scale C

   (NOTE: Figure concrete to the next one-quarter yard.)

   EXAMPLE 1: Slab dimensions: 4" thick × 42 1/2'
   Wide × 40' long

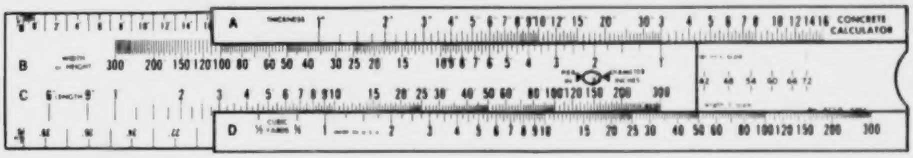

A
THICKNESS
CONCRETE CALCULATOR
B
WIDTH OR HEIGHT
C
LENGTH
D
CUBIC YARDS

a. Align 4 inches on scale A with 42 1/2 feet on scale B

b. Locate 40 feet on scale C and read figure on scale D that is aligned with it

c. Answer is 21 1/2 cubic yards

EXAMPLE 2: Wall with dimensions — 8" thick × 54" high × 60' long


A
THICKNESS
CONCRETE CALCULATOR
B
WIDTH OR HEIGHT
C
LENGTH
D
CUBIC YARDS

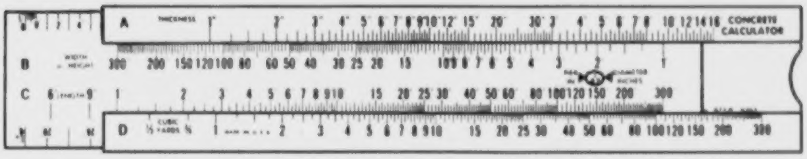
SUGGESTED ACTIVITIES

a. Align 8 inches on scale A with 54 inches (4′ –6″) on scale B

b. Locate 60 feet on scale C and read figure on scale D that is aligned with it

c. Answer is 6 3/4 cubic yards

EXAMPLE 3: Circular column with dimensions — 3′ –6″ diameter ×
16′ high


A
THICKNESS
1″ 2″ 3″ 4″ 5″ 6″ 7″ 8″ 9″ 10″ 12″ 15″ 20″ 30″ 3′ 4′ 5′ 6′ 7′ 8′ 10′ 12′ 14′ 16′
CONCRETE CALCULATOR
B
WIDTH or HEIGHT
300 200 150 120 100 80 60 50 40 30 25 20 15 10 9 8 7 6 5 4 3 2 1
DIAMETER INCHES
C
6′ LENGTH 9′
1 2 3 4 5 6 7 8 9 10 15 20 25 30 40 50 60 80 100 120 150 200 300
D
CUBIC YARDS
1 2 3 4 5 6 7 8 9 10 15 20 25 30 40 50 60 80 100 120 150 200 300

a. Locate circular form 42″ in window

b. Locate length or height 16′ on C scale

c. Read cubic yards 5 3/4 on D scale under 16′

d. Answer is 5 3/4 cubic yards

Using concrete estimating table (Furnish students with estimating table)

1. Locate desired thickness in column A
2. Read across from desired thickness in column A and identify square feet in column B
3. Calculate the square feet for job
4. Divide square feet of job by square feet in column B

EXAMPLE: Slab dimensions 4″ thick × 20′
wide × 80′ long

a. 4 inches on table = 81 square feet

b. Square feet of job 40′ × 80′ = 3200 square feet

c. 3200 square feet + 81 square feet = 39.5 cubic yards

d. Answer is 30 1/2 cubic yards

SUGGESTED ACTIVITIES

Using formula for estimating concrete

Formula: $$\frac{\text{Width in Feet} \times \text{Length in Feet} \times \text{Thickness in Feet}}{27} = \text{Cubic Feet of Concrete}$$

(NOTE: Thickness quite often being in inches, has to be broken down by using fractions or decimals.)

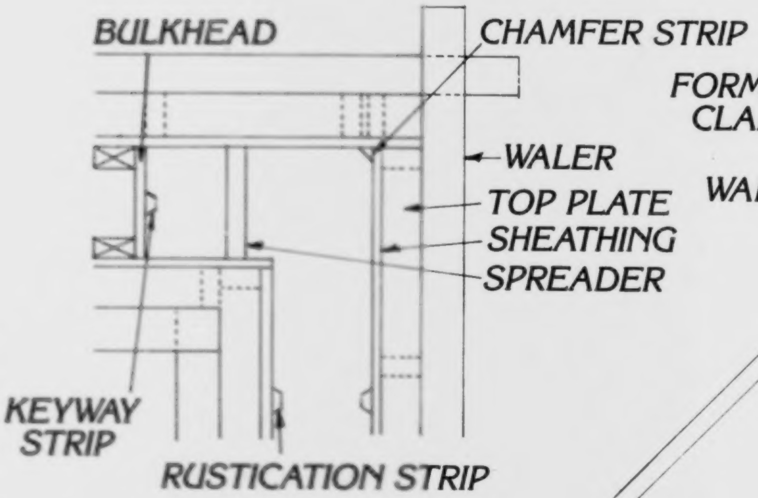
EXAMPLE: Using a fraction

$$\frac{30' \times 60' \times 4''}{27} = \frac{30' \times 60' \times {}^{4}/_{12}' \text{ or } {}^{1}/_{3}'}{27} = 22.22 \text{ cubic yards}$$

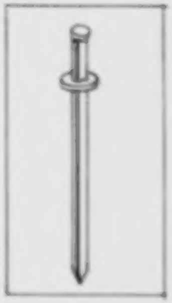
EXAMPLE: Using a decimal

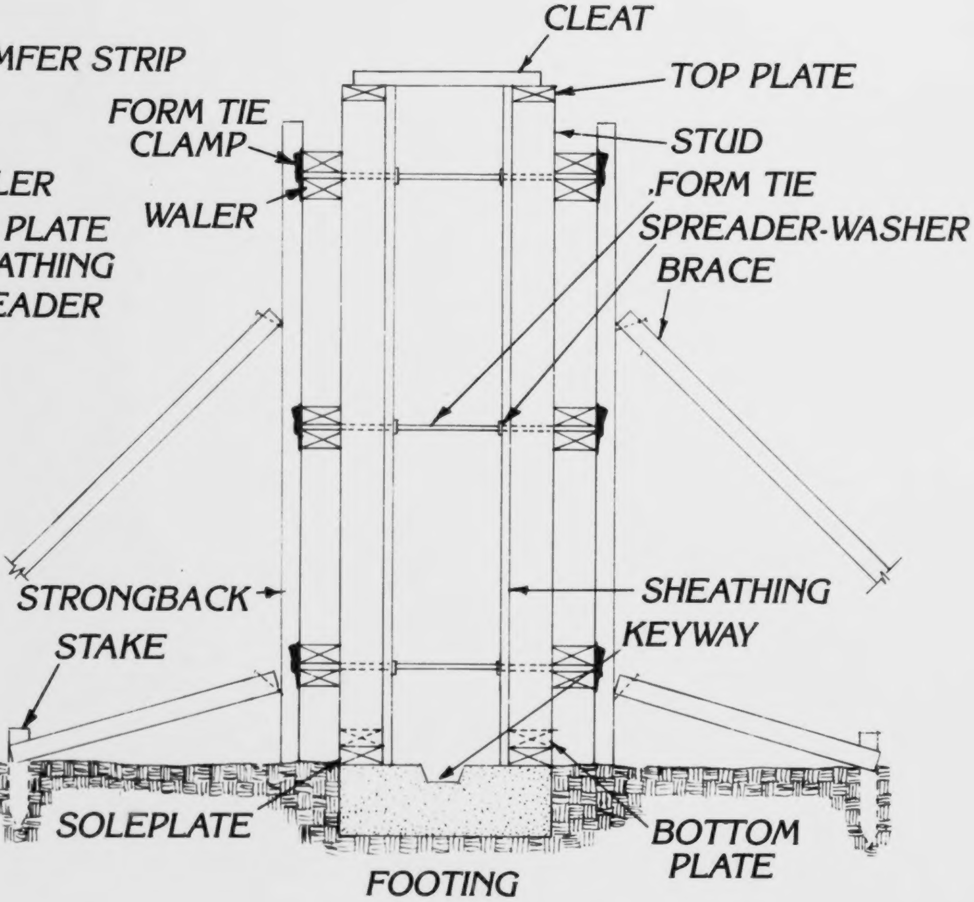
$$\frac{30' \times 60' \times 4''}{27} = \frac{30' \times 60' \times .33'}{27} = \frac{594}{27} = 22 \text{ cubic yards}$$

Parts of a Form

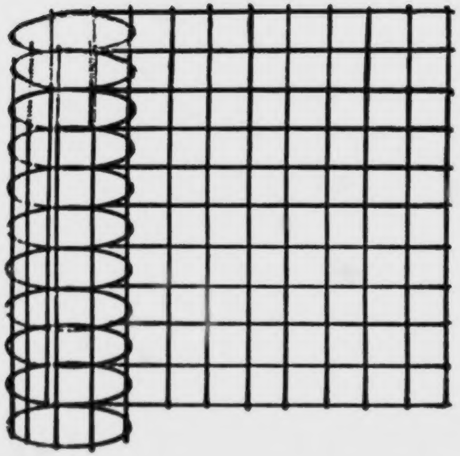

BULKHEAD
CHAMFER STRIP
WALER
TOP PLATE
SHEATHING
SPREADER
KEYWAY STRIP
RUSTICATION STRIP

DUPLEX NAIL

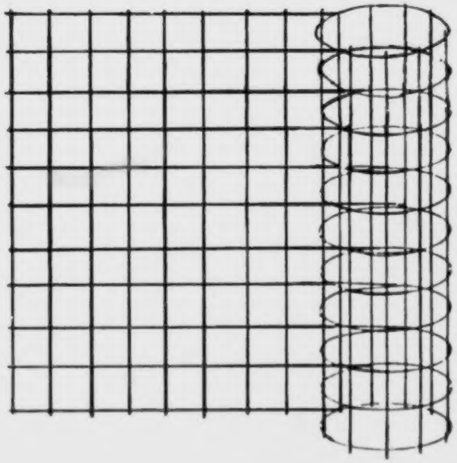



CLEAT
TOP PLATE
FORM TIE CLAMP
STUD
FORM TIE
WALER
SPREADER-WASHER
BRACE
STRONGBACK
SHEATHING
STAKE
KEYWAY
SOLEPLATE
BOTTOM PLATE
FOOTING

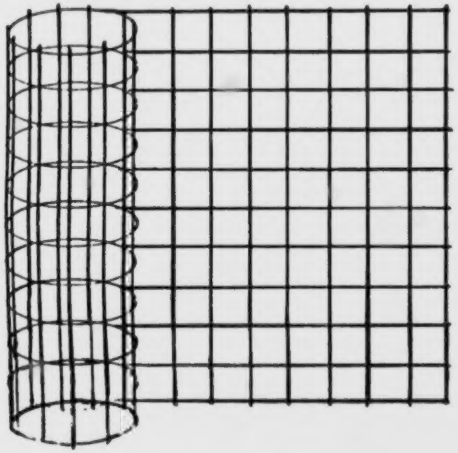
Standard Sizes of Welded Wire Mesh



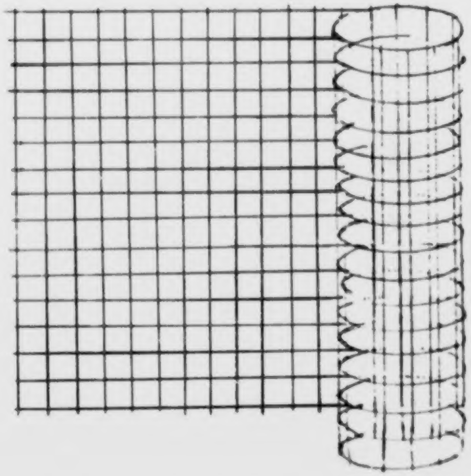
6×6—W2.9 × W2.9



6×6—W2.0 × W2.0



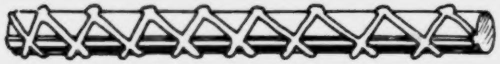
6×6—W1.4 × W1.4



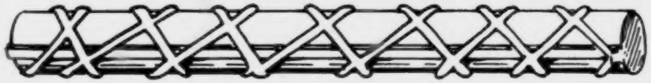
4×4—W1.4 × W1.4

Sizes of Reinforcing Bars

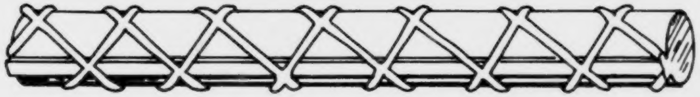
#2-1/4 Inch



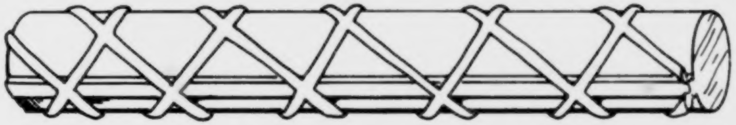
#3-3/8 Inch



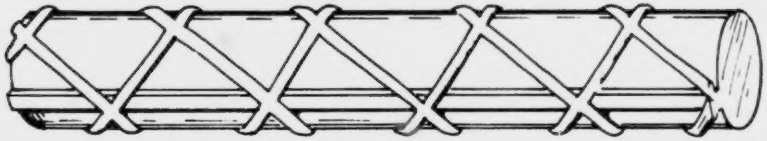
#4-1/2 Inch



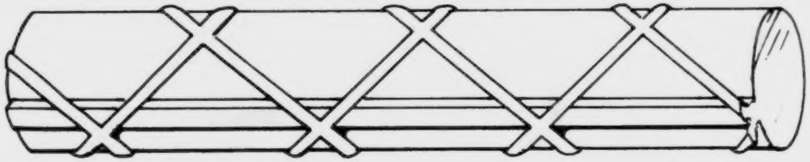
#5-5/8 Inch



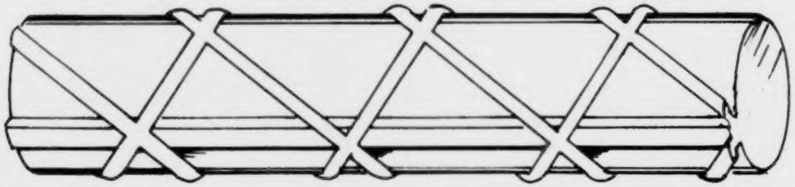
#6-3/4 Inch



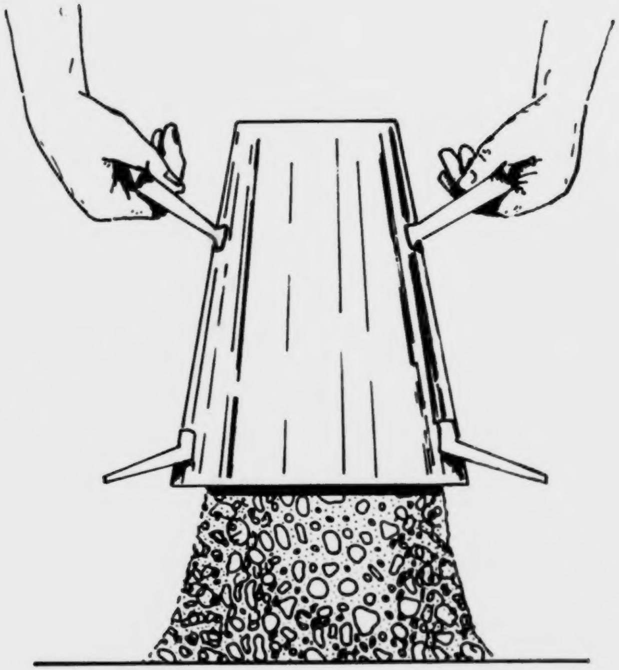
#7-7/8 Inch



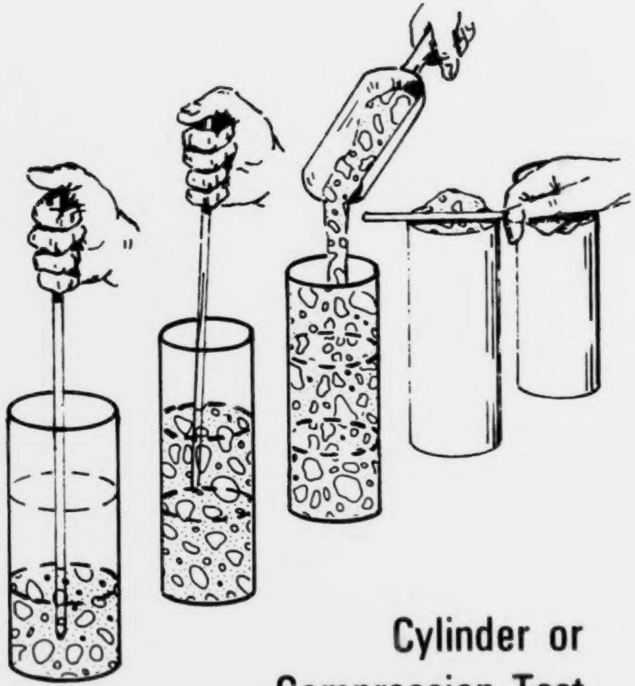
#8-1 Inch



Types of Concrete Tests



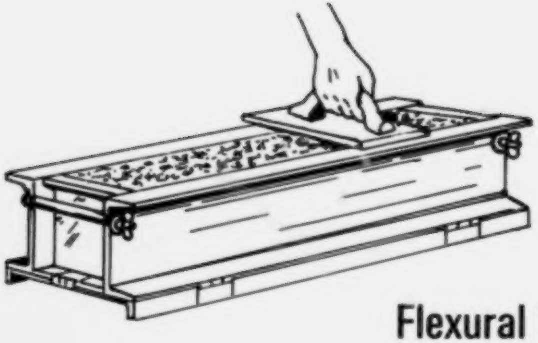
Slump Test



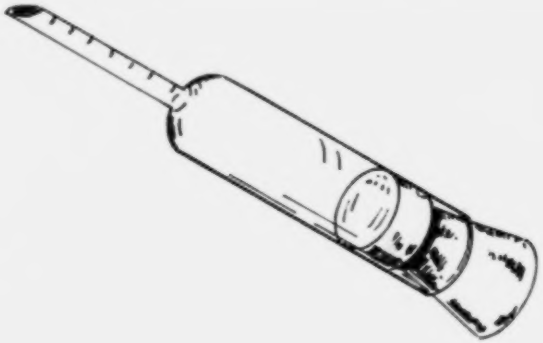
Cylinder or
Compression Test

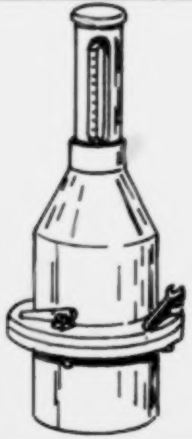
Types of Concrete Tests

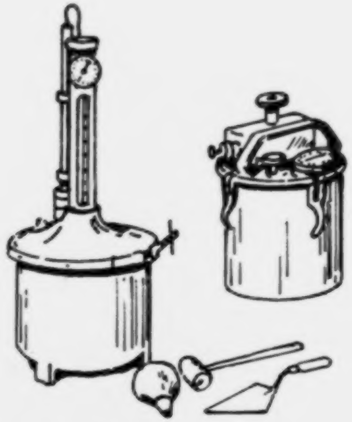
(Continued)



Flexural Test



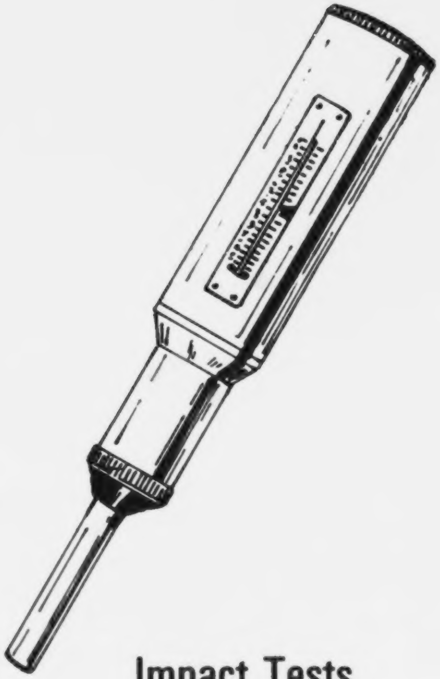




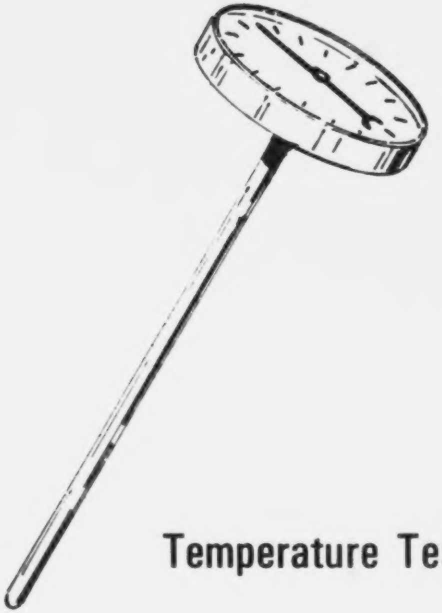
Air Tests

Types of Concrete Tests

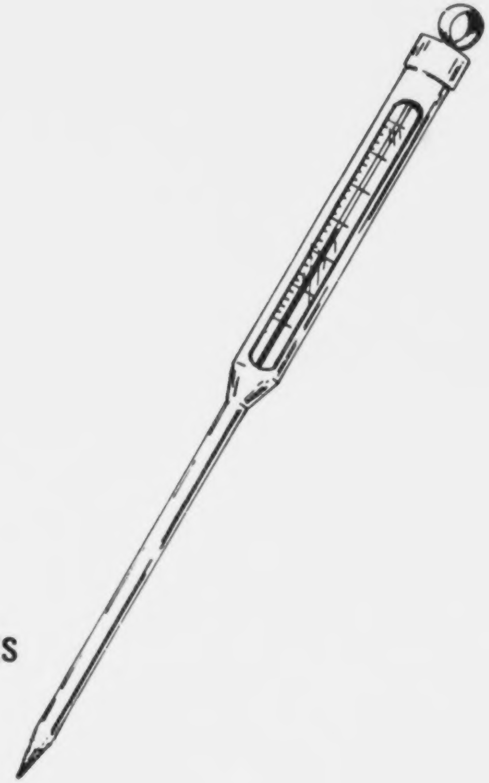
(Continued)



Impact Tests

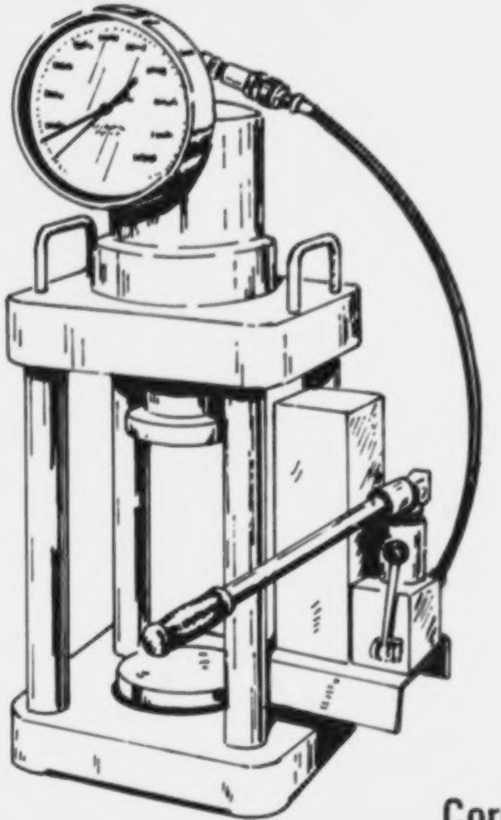


Temperature Tests



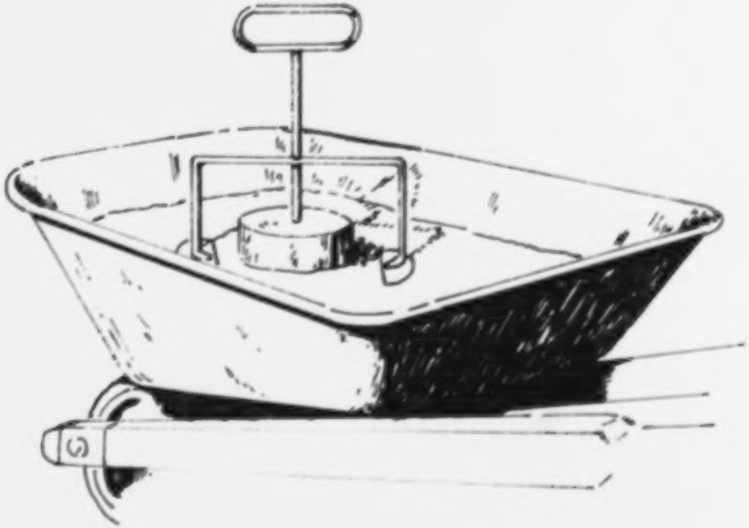
Types of Concrete Tests

(Continued)

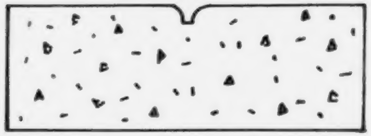


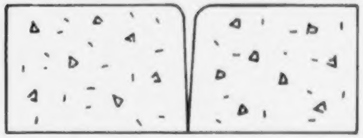
Core Test

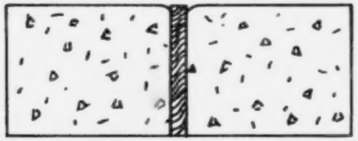
Ball Penetration Test

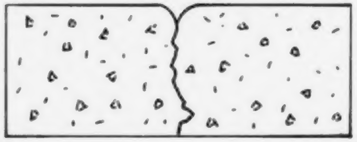


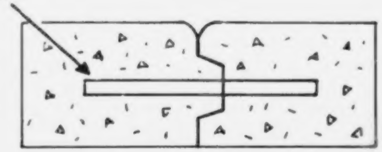
Types of Joints

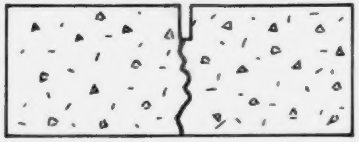

TOOLED DUMMY JOINT

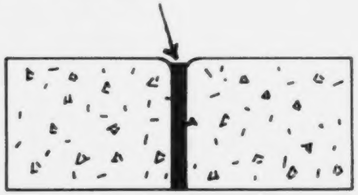

OPEN JOINT FOR FILLING


DECORATIVE JOINT
WITH WOOD SPACER


TOOLED CONTROL JOINT

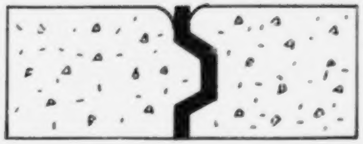

DEFORMED TIE BARS
TOOLED CONSTRUCTION
JOINT WITH KEYWAY


SAWED CONTROL JOINT

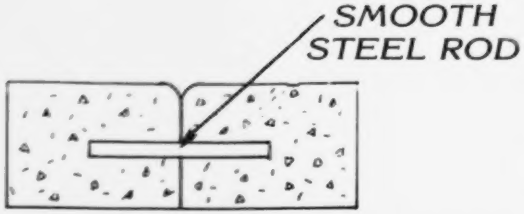

EXPANSION
MATERIAL
TOOLED CONSTRUCTION JOINT
WITH EXPANSION MATERIAL

Types of Joints

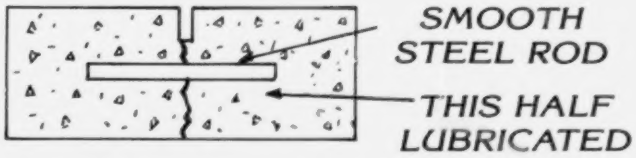
(Continued)



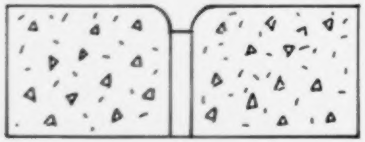
TOOLED CONSTRUCTION JOINT
WITH KEYED EXPANSION


SMOOTH
STEEL ROD

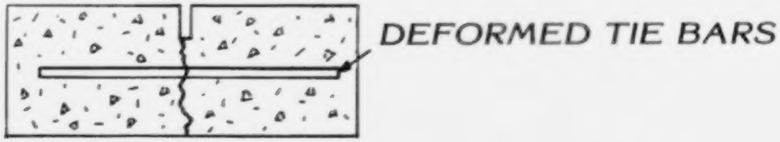
TOOLED CONSTRUCTION JOINT
WITH STEEL DOWEL


SMOOTH
STEEL ROD
THIS HALF
LUBRICATED

SAWED CONTRACTION JOINT
WITH STEEL DOWEL

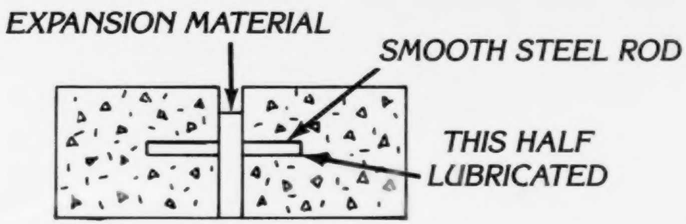


TOOLED ISOLATION JOINT
HELD DOWN FOR SEALANT

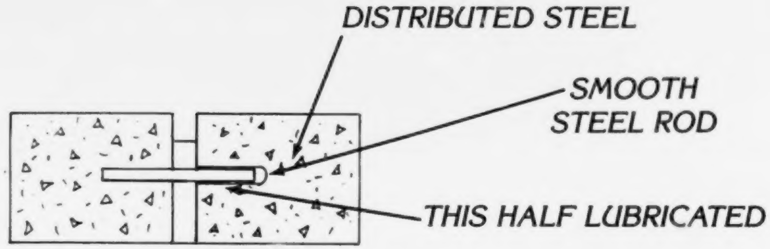

DEFORMED TIE BARS

SAWED LONGITUDINAL JOINT

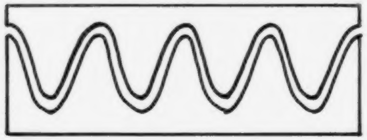
Types of Joints
(Continued)


EXPANSION MATERIAL
SMOOTH STEEL ROD
THIS HALF LUBRICATED

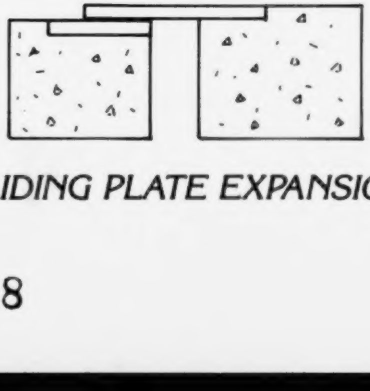
TOOLED ISOLATION JOINT WITH CAPPED STEEL ROD


DISTRIBUTED STEEL
SMOOTH STEEL ROD
THIS HALF LUBRICATED

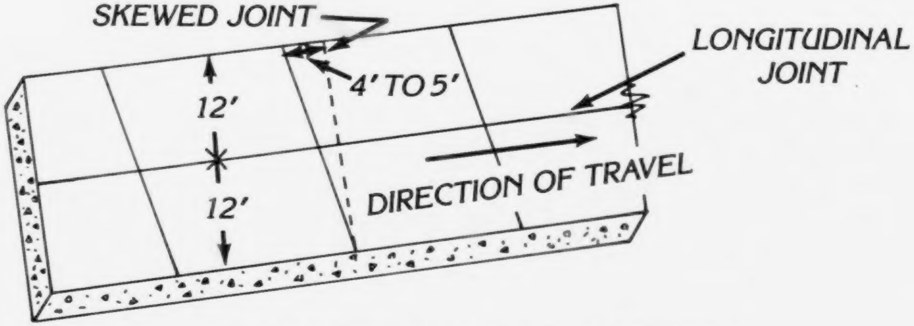
SAWED CONTRACTION JOINT WITH STEEL DOWEL AND DISTRIBUTED STEEL



FINGER EXPANSION

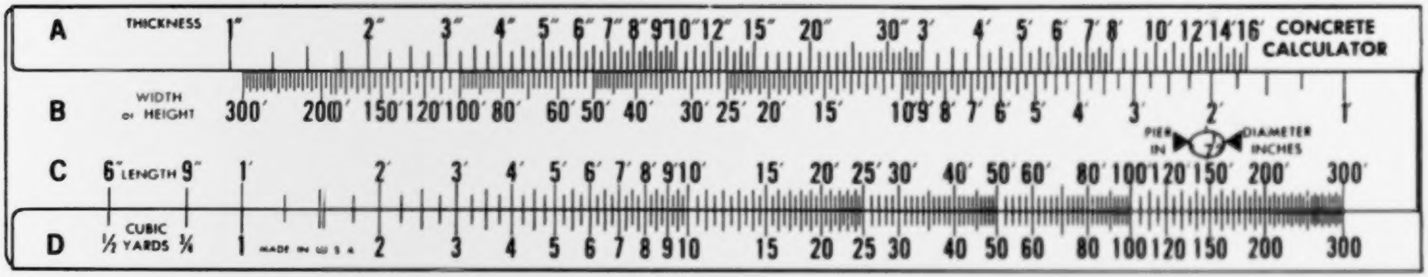


SLIDING PLATE EXPANSION


SKEWED JOINT
4' TO 5'
12'
12'
LONGITUDINAL JOINT
DIRECTION OF TRAVEL

LONGITUDINAL AND SKEWED JOINTS IN PAVEMENT

Concrete Calculator


A THICKNESS 1" 2" 3" 4" 5" 6" 7" 8" 9" 10" 12" 15" 20" 30" 3' 4' 5' 6' 7' 8' 10' 12' 14' 16'
CONCRETE CALCULATOR
B WIDTH or HEIGHT 300' 200' 150' 120' 100' 80' 60' 50' 40' 30' 25' 20' 15' 10' 9' 8' 7' 6' 5' 4' 3' 2' 1'
PIER IN DIAMETER INCHES
C 6" LENGTH 9" 1' 2' 3' 4' 5' 6' 7' 8' 9' 10' 15' 20' 25' 30' 40' 50' 60' 80' 100' 120' 150' 200' 300'
D CUBIC ½ YARDS ¾ 1 MADE IN U S A 2 3 4 5 6 7 8 9 10 15 20 25 30 40 50 60 80 100 120 150 200 300

Concrete Estimating Table

Depth (Inches)	Square Feet
1	324
1 1/4	259
1 1/2	216
1 3/4	185
2	162
2 1/4	144
2 1/2	130
2 3/4	118
3	108
3 1/4	100
3 1/2	93
3 3/4	86
4	81
4 1/4	76
4 1/2	72
4 3/4	68
5	65
5 1/4	62
5 1/2	59
5 3/4	56
6	54
6 1/4	52
6 1/2	50
6 3/4	48
7	46
7 1/4	45
7 1/2	43
7 3/4	42
8	40
8 1/4	39
8 1/2	38
8 3/4	37
9	36
9 1/4	35
9 1/2	34
9 3/4	33
10	32.5
10 1/4	31.5
10 1/2	31
10 3/4	30
11	29.5
11 1/4	29
11 1/2	28
11 3/4	27.5
12	27

INTRODUCTION TO FORMING
UNIT I

INFORMATION SHEET

I. Terms and definitions

   A. Set — Actual hardening of concrete

   B. Slump — Consistency (wetness) of concrete

   C. Hydration — Chemical reaction set up by the water leaving the concrete which causes the concrete to harden

   D. Vibration — Quivering or trembling motion of a tool used to consolidate concrete, bond it to reinforcing, settle it to the forms and to remove harmful air pockets

   E. Puddling — Hand method of vibrating concrete

   F. Waler — Horizontal brace used in form construction

   G. Strongback — Vertical brace

   H. Form tie — Metal crosstie used in forms to support pressure of wet concrete and maintain proper wall thickness

   I. Chamfer strip — Triangular wood strip used to form a bevel on the edge or corner of the concrete

   J. Spreader — Strip of wood used to hold sides of form the proper distance apart; removed as the concrete is placed; may also be an integral part of the form tie

   K. Bulkhead — Board placed in a form to cut off the concrete pour

   L. Keyway strip — Beveled wood or metal strip placed on the form to shape the keyway where future pours will occur

   M. Rustication strip — Beveled wood, metal, or plastic strip used to create a design or pattern in the concrete

II. Purposes of forms — To hold concrete to specified shapes and dimensions until the concrete has set

III. Types of forms

   A. Footing forms

   B. Wall forms

INFORMATION SHEET

C. Slab forms on grade

D. Curb forms

E. Pier and column forms

F. Beam forms

G. Slab forms above grade

H. Fireproof encasement forms

I. Stair forms

J. Single or one-sided wall form against an embankment

IV. Effects of external factors on form design

A. Slump — The greater the slump, the longer it takes concrete to set; therefore, the pressure remains on the forms a longer period of time

B. Rate of pour — Feet of concrete depth poured in one hour

C. Temperature — Affects the rate at which hydration of concrete occurs; the higher the temperature, the faster concrete sets

EXAMPLE: With a rate of pour of four feet per hour at 70°, the maximum pressure on the form is 550# per square foot (p.s.f.). Using the same rate of pour at 50°, the maximum pressure increases to 750# per square foot.

D. Vibration — Power vibration causes pressure to increase as much as 35 percent

(NOTE: Puddling [hand spading] has very little effect on pressure.)

E. Method of placement — Concrete weighs 150 pounds per cubic foot; the impact of this weight on concrete already placed causes an increase in pressure on the forms; the greater the height of the drop and the mass of concrete, the greater the pressure increases

(NOTE: High, free-drop of concrete also causes aggregate separation.)

F. Size of forms — Thickness and length of the wall are used to figure the rate of pour; height and width have no bearing on pressure on forms, except for the method of placement

EXAMPLE: For a given rate of fill, the pressure will be the same on a four inch wide wall as it is on a twelve inch wide wall.

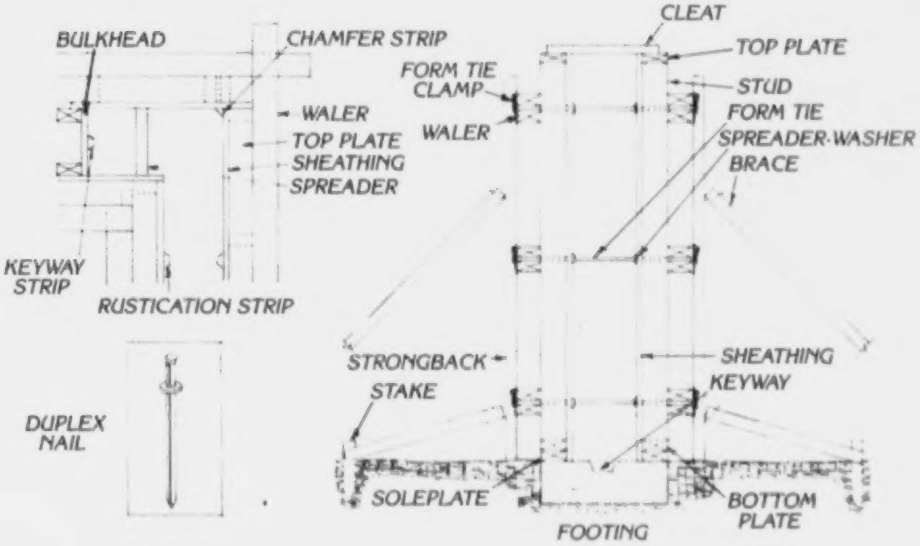
G. Types of concrete finishes

1. Architectural concrete — Will be exposed in the finished area of the structure; forms will be designed to give a minimum of deflection and leakage; the concrete surface may be smooth, rough, incised, sculptured, sandblasted, bush-hammered, or many other finishes

2. Structural concrete — Will not be exposed in the finished area of the structure, so some deflection and leakage is permissible

V. Parts of a basic form (Figure 1)

FIGURE 1


BULKHEAD
CHAMFER STRIP
WALER
TOP PLATE
SHEATHING
SPREADER
KEYWAY STRIP
RUSTICATION STRIP
DUPLEX NAIL
CLEAT
TOP PLATE
FORM TIE CLAMP
STUD
WALER
FORM TIE
SPREADER-WASHER
BRACE
STRONGBACK
SHEATHING
STAKE
KEYWAY
SOLEPLATE
BOTTOM PLATE
FOOTING

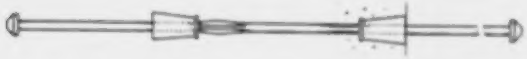
INFORMATION SHEET

VI. Hardware used on forms (Figures 2 - 12)

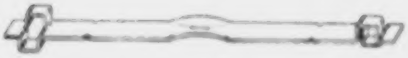
A. Form tie and form-tie clamp

EXAMPLES:

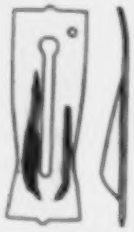
FIGURE 2



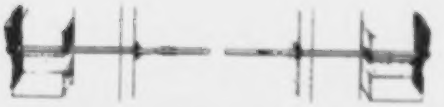
WASHER-TYPE



STRAP-TYPE



CLAMP (HAIRPIN)

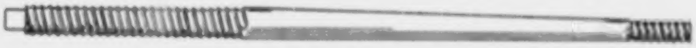


ASSEMBLY (CONE-TYPE)

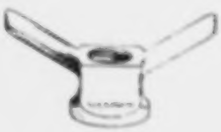
B. She-bolt form tie

EXAMPLES:

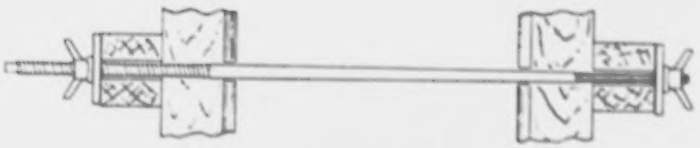
FIGURE 3



BOLT



NUT



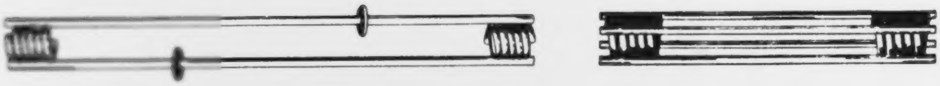
ASSEMBLY

INFORMATION SHEET

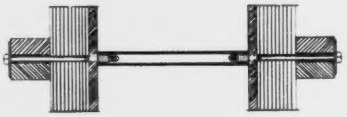
C. Coil ties

EXAMPLES:

FIGURES 4



TWO-STRUT *FOUR-STRUT*

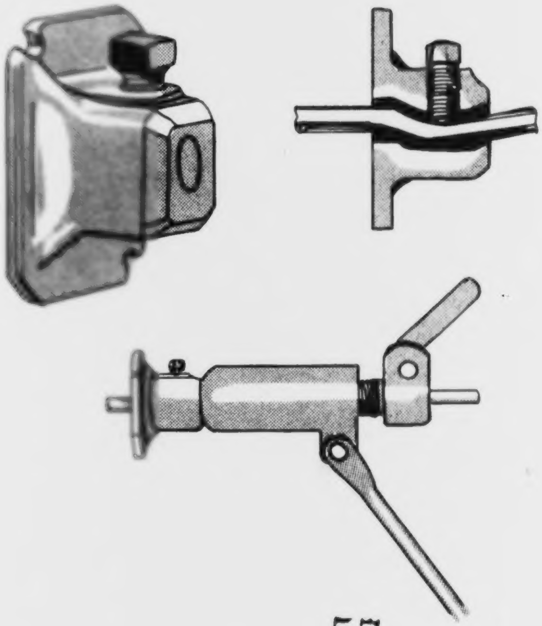


ASSEMBLY

D. Rod clamps (used with plain round steel rods)

EXAMPLES:

FIGURE 5

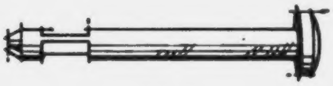


INFORMATION SHEET

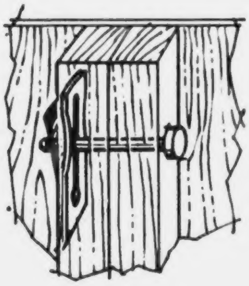
E. Panel back bolts and panel clamps

EXAMPLES:

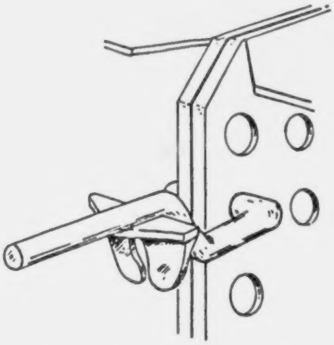
FIGURE 6



BOLT



BOLT ASSEMBLY

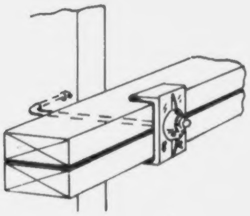


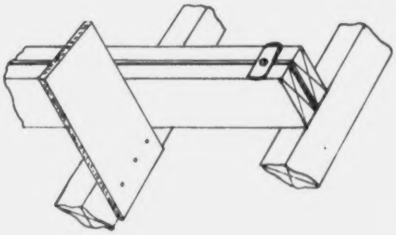
PANEL CLAMP ASSEMBLY

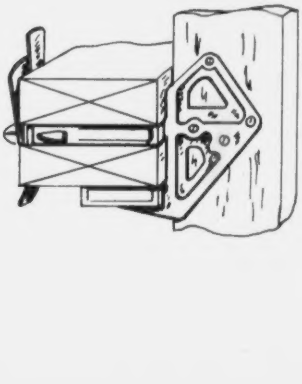
F. Waler support brackets

EXAMPLES:

FIGURE 7





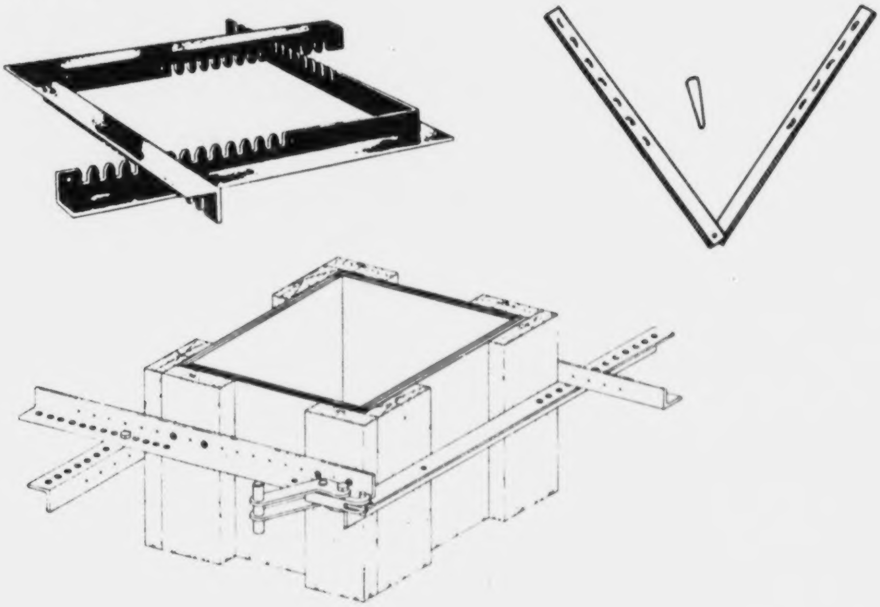


INFORMATION SHEET

G. Column clamps

EXAMPLES:

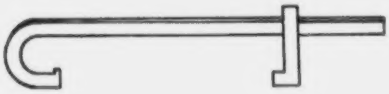
FIGURE 8



H. Hammer clamp

EXAMPLE:

FIGURE 9

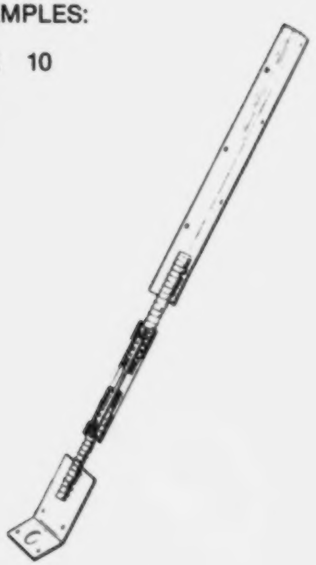


INFORMATION SHEET

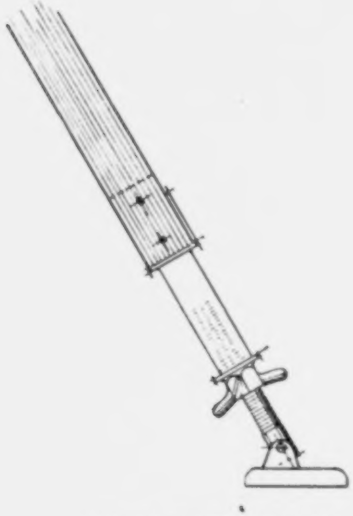
I. Form braces

EXAMPLES:

FIGURE 10



TURNBUCKLE-TYPE

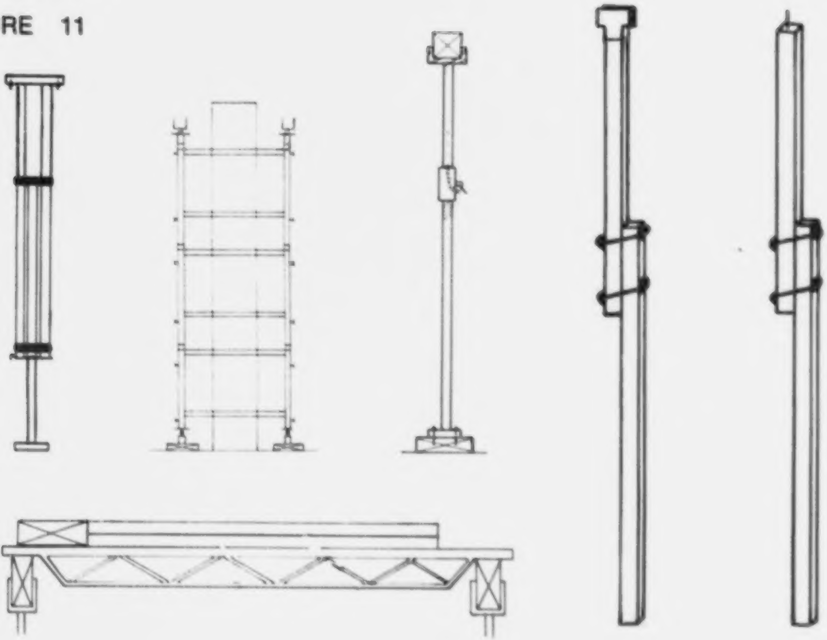


ADJUSTABLE UNIT WITH DIMENSIONAL LUMBER

J. Shores (vertical and horizontal)

EXAMPLES:

FIGURE 11



INFORMATION SHEET

FIGURE 12

Concrete Estimating Table

Depth (Inches)	Square Feet
1	324
1 1/4	259
1 1/2	216
1 3/4	185
2	162
2 1/4	144
2 1/2	130
2 3/4	118
3	108
3 1/4	100
3 1/2	93
3 3/4	86
4	81
4 1/4	76
4 1/2	72
4 3/4	68
5	65
5 1/4	62
5 1/2	59
5 3/4	56
6	54
6 1/4	52
6 1/2	50
6 3/4	48
7	46
7 1/4	45
7 1/2	43
7 3/4	42
8	40
8 1/4	39
8 1/2	38
8 3/4	37
9	36
9 1/4	35
9 1/2	34
9 3/4	33
10	32.5
10 1/4	31.5
10 1/2	31
10 3/4	30
11	29.5
11 1/4	29
11 1/2	28
11 3/4	27.5
12	27

INTRODUCTION TO FORMING
UNIT I

JOB SHEET #1 — MAKE A SLUMP TEST

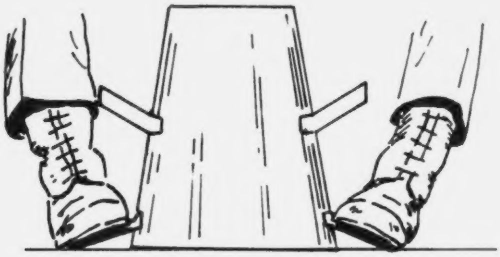
I. Tools and materials

- A. Wheelbarrow
- B. Slump cone mold
- C. Bullet-nosed steel rod (smooth), 5/8" by 24"
- D. Scoop or trowel
- E. Folding rule or steel tape
- F. Concrete
- G. Water in container

II. Procedure

- A. Collect concrete in wheelbarrow
- B. Dampen slump cone mold with water
- C. Place slump cone mold on firm, level, clean, nonabsorbent surface
- D. Stand on the foot pieces of cone mold to hold it firmly in place (Figure 13)

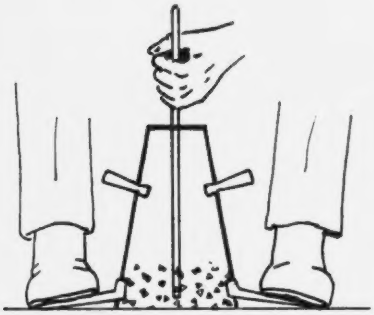
FIGURE 13



JOB SHEET #1

E. Fill one third of cone mold with concrete (Figure 14)

FIGURE 14

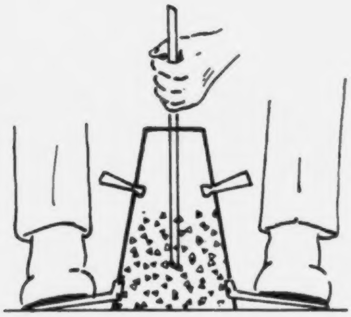


F. Rod with up and down motion twenty-five times, using steel rod

(NOTE: Always distribute rodding strokes evenly by starting at outer edge and moving in a spiral toward center.)

G. Fill two thirds of cone mold with concret (Figure 15)

FIGURE 15

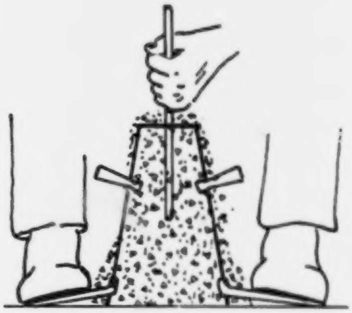


H. Rod twenty-five times, barely penetrating into first layer

JOB SHEET #1

I. Fill cone mold to overflowing with concrete (Figure 16)

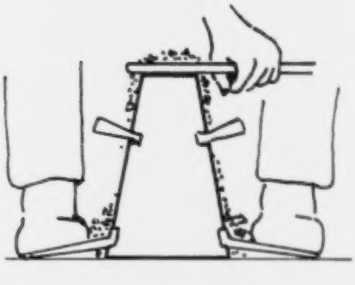
FIGURE 16



J. Again rod twenty-five times, taking same precautions about depth and distribution of strokes

K. Level top of cone with steel rod so that cone mold is level full (Figure 17)

FIGURE 17



L. Clean excess concrete away from base of cone mold

M. Immediately raise cone mold, taking only five to ten seconds to perform this operation

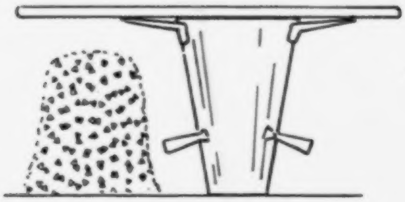
> **CAUTION**
>
> Perform this operation with a steady upward lift. Do not shake mold in any way or disturb the sample.

N. Place cone mold next to sample upside down, taking caution not to disturb it

JOB SHEET #1

O. Place steel rod horizontally across mold so that it extends over the sample (Figure 18)

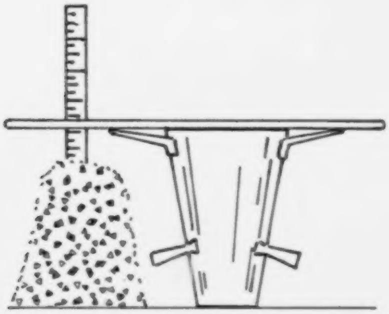
FIGURE 18



P. Measure distance from bottom of steel rod to the point of the original center of sample (Figure 19)

(NOTE: This measurement, to the nearest 1/4", is the slump of the concrete.)

FIGURE 19



Q. Put away equipment and materials and clean work area

INTRODUCTION TO FORMING
UNIT I

JOB SHEET #2 — MAKE A CYLINDER CAST

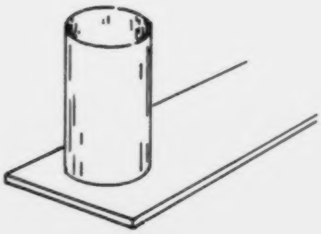
I. Tools and materials

- A. Wheelbarrow
- B. Molds and tags furnished by instructor
- C. Bullet-nosed steel rod (smooth), 5/8" by 24"
- D. Scoop or trowel
- E. Concrete
- F. Shovel

II. Procedure

- A. Take concrete sample from three parts of load in wheelbarrow
- B. Remix concrete sample in wheelbarrow with shovel
- C. Place cylinder mold on firm, level surface (Figure 20)

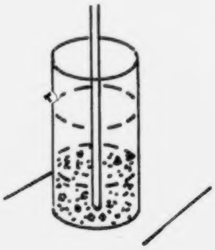
FIGURE 20



JOB SHEET #2

D. Fill one-third of cylinder mold with concrete (Figure 21)

FIGURE 21

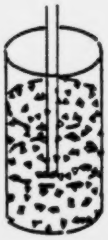


E. Rod with up and down motion twenty-five times using the steel rod

(NOTE: Always distribute rodding strokes evenly by starting at outer edge and moving in a spiral toward center.)

F. Fill two-thirds of cylinder mold with concrete (Figure 22)

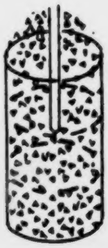
FIGURE 22



G. Rod twenty-five times, barely penetrating into first layer

H. Fill cylinder mold to overflowing with concrete (Figure 23)

FIGURE 23



JOB SHEET #2

I. Again rod twenty-five times, taking same precautions about depth and distribution of strokes

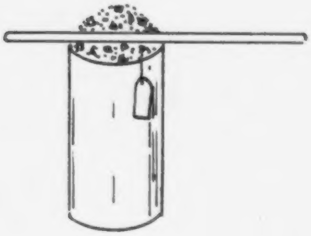
J. Level top of mold with steel rod so that it is level full (Figure 24)

K. Tag cylinder

    a. Fill out information on tag

    b. Insert ends of wire into concrete along edge of mold

FIGURE 24



L. Clean excess concrete from around cylinder mold

M. Cover top of mold to prevent loss of moisture

N. Do not move mold for at least twenty-four hours

CAUTION

Be careful during handling since it is necessary that molds do not suffer any damage

(NOTE: Cylinders should be cast in a protected area where temperatures will not exceed 80 F [27 C] or fall below 60 F [16 C]. After twenty-four hours, cylinders should be stored under conditions that maintain 60-80 F [16-27°C] and tops should be covered to prevent loss of moisture. Specimens can also be sent to a laboratory for similar standard curing.)

INTRODUCTION TO FORMING
UNIT I

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with forming to their correct definitions. Write the correct numbers in the blanks.

______a. Triangular wood strip used to form a bevel on the edge or corner of the concrete

______b. Vertical brace

______c. Chemical reaction set up by the water leaving the concrete which causes the concrete to harden

______d. Beveled wood or metal strip used to create a design or pattern in the concrete

______e. Metal crosstie used in forms to support pressure of wet concrete and maintain proper wall thickness

______f. Board placed in a form to cut off the concrete pour

______g. Actual hardening of concrete

______h. Quivering or trembling motion of a tool used to consolidate concrete, bond it to reinforcing, settle it to the forms and to remove harmful air pockets

______i. Consistency (wetness) of concrete

______j. Strip of wood used to hold sides of form the proper distance apart; removed as the concrete is poured; may also be an integral part of the form tie

______k. Hand method of vibrating concrete

______l. Beveled wood, metal, or plastic strip placed on the form to shape the keyway where future pours will occur

______m. Horizontal brace used in form construction

1. Slump
2. Rustication strip
3. Vibration
4. Bulkhead
5. Chamfer strip
6. Waler
7. Spreader
8. Hydration
9. Puddling
10. Set
11. Keyway strip
12. Strongback
13. Form tie

2. Explain the purpose of forms.

____

____

TEST

3. Name five types of forms.

a. ____

b. ____

c. ____

d. ____

e. ____

4. Match external factors that affect form design to their effects. Write the correct numbers in the blanks.

_____a. Affects the rate at which hydration of concrete occurs; the higher the temperature, the faster concrete sets

_____b. Concrete weighs 150 pounds per cubic feet; the impact of this weight on concrete already placed causes an increase in pressure on the forms; the greater the height of the drop and the mass of concrete, the greater the pressure increase

_____c. Feet of concrete depth poured in one hour

_____d. Thickness and length of the wall are used to figure the rate of pour; height and width have no bearing on pressure on forms, except for the method of placement

_____e. Power vibration causes pressure to increase as much as 35%

_____f. The greater the slump, the longer it takes concrete to set; therefore, the pressure remains on the forms a longer period of time

_____g. 1. Architectural concrete — will be exposed in the finished area of the structure; forms will be designed to give a minimum of deflection and leakage; the concrete surface may be smooth, rough, incised, sculptured, sandblasted, bushhammered, or many other finishes

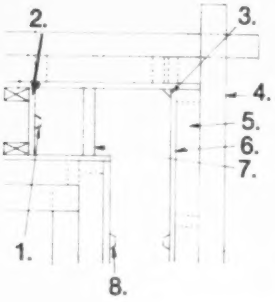
2. Structural concrete — will not be exposed in the finished are of the structure, so some deflection and leakage is permissible

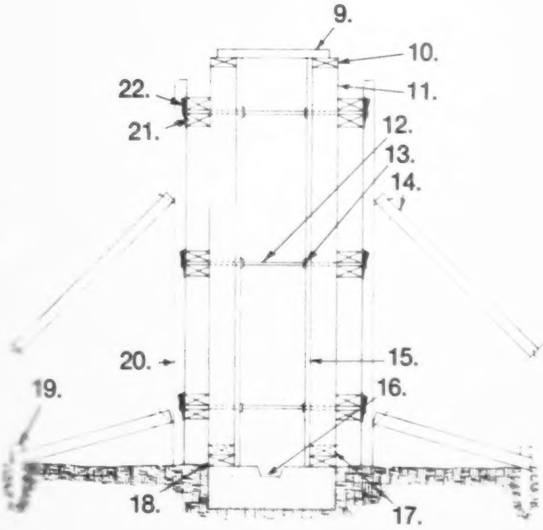
1. Rate of pour
2. Types of concrete finishes
3. Vibration
4. Method of placement
5. Slump
6. Size of forms
7. Temperature

TEST

5. Identify parts of the form illustrated. Write the correct numbers in the blanks. Some blanks will have more than one answer.

___a. Sheathing
___b. Top plate
___c. Bulkhead
___d. Sole plate
___e. Rustication
___f. Stud
___g. Waler
___h. Brace
___i. Cleat
___j. Keyway
___k. Form tie
___l. Bottom plate
___m. Spreader
___n. Stake
___o. Spreader-washer
___p. Strongback
___q. Form tie clamp
___r. Chamfer strip
___s. Keyway strip




9.
10.
22.
11.
21.
12.
13.
14.
20.
15.
19.
16.
18.
17.

TEST

6. Name six types of hardware used on forms.

   a. ______

   b. ______

   c. ______

   d. ______

   e. ______

   f. ______

(NOTE: Test question 7 lists the job sheets. It is an important part of this test. If it has not been completed, check with your instructor.)

7. Demonstrate the ability to

   a. Make a slump test.

   b. Make a cylinder cast.

INTRODUCTION TO FORMING
UNIT I

ANSWERS TO TEST

1. a. 5
   b. 12
   c. 8
   d. 2
   e. 13
   f. 4
   g. 10
   h. 3
   i. 1
   j. 7
   k. 9
   l. 11
   m. 6

2. Answer should include the following

   Purpose of forms — To hold concrete to specified shapes and dimensions until the concrete has set

3. Answer should include any five of the following

   a. Footing forms
   b. Wall forms
   c. Slab forms on grade
   d. Curb forms
   e. Pier and column forms
   f. Beam forms
   g. Slab forms above grade
   h. Fireproof encasement forms
   i. Stair forms

4. a. 7
   b. 4
   c. 1
   d. 6
   e. 3
   f. 5
   g. 2

5. a. 6, 15
   b. 5, 10
   c. 2
   d. 18
   e. 8
   f. 11
   g. 4, 21
   h. 14
   i. 9
   j. 16
   k. 12
   l. 17
   m. 7
   n. 19
   o. 13
   p. 20
   q. 22
   r. 3
   s. 1

6. Answer should include any six of the following

   a. Form tie and form-tie clamp
   b. She bolt form tie
   c. Coil ties

ANSWERS TO TEST

   d. Rod clamps
   e. Panel lock bolts and panel clamps
   f. Waler support brackets
   g. Column clamps
   h. Hammer clamp
   i. Form braces
   j. Shores

7. Performance skills evaluated to the satisfaction of the instructor

FOOTING FORMS
UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to construct and set various types of footing forms. The student will show this knowledge by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with footing forms.
2. Select from a list factors that control the size and shape of footings.
3. Name types of footings.
4. Name footing styles.
5. Identify the parts of a footing form.
6. Identify the parts of a pier footing form.
7. Demonstrate the ability to
   a. Construct and set forms for a continuous footing.
   b. Construct and set forms for a pile cap 4′ −0″ × 8′ −0″.
   c. Construct and set forms for a pier footing.
   d. Strip pier footing forms and prepare for erection at another location.

FOOTING FORMS
UNIT II

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

      1. Supplements

         a. Supplement #1 — Importance of Form Design

         b. Supplement #2 — Guidelines for Constructing Footing Forms

      2. Transparency masters

         a. TM #1 — Parts of a Spread Footing Form

         b. TM #2 — Parts of a Step Footing Form

         c. TM #3 — Parts of a Pier Footing Form

   C. Information sheet

   D. Job sheets

      1. Job Sheet #1 — Construct and Set Forms for a Continuous Footing

      2. Job Sheet #2 — Construct and Set Forms for a Pile Cap 4′-0″ × 8′-0″

      3. Job Sheet #3 — Construct and Set Forms for a Pier Footing

      4. Job Sheet #4 — Strip Pier Footing Forms and Prepare for Erection at Another Location

   E. Test

   F. Answers to test

II. Instructor's guide

   A. Review unit and plan presentation.

   B. Obtain materials to supplement unit.

      1. Equipment and materials for procedures outlined in the job sheets

      2. Copies of supplements as appropriate

SUGGESTED ACTIVITIES

3. Transparencies and competency profiles

   (NOTE: Transparencies and competency profiles for this manual are available from the Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N. W., Washington, D. C. 20006; phone 202-393-2040.)

4. Resource materials

   a. Books

      1) Latest edition of *Modern Carpentry* by Willis H. Wagner

         (NOTE: Order from the Goodheart-Willcox Co., Inc., 123 West Taft Drive, South Holland, Illinois 60473.)

      2) Latest edition of *Carpentry* by Caspar J. Lewis

         (NOTE: Order from Delmar Publishers Incorporated, 2 Computer Drive West, Box 15-015, Albany, New York 12212.)

   b. Film — *The Foundation*

      (NOTE: This film illustrates the step-by-step procedure for building a concrete basement and includes a segment on placing and pouring footings. It is available on a free-loan basis to Oklahoma teachers, who may order from the State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074. Out-of-state teachers may order from Circle Oak Productions, 73 Girdle Ridge Drive, Katonah, New York 10536.)

C. Prepare sites by digging excavations, erecting batter boards, and sawing building line kerfs so that students may complete Job Sheets #1 through #3.

D. Provide students with objective sheet.

E. Introduce unit to students by discussing unit and specific objectives.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

   1. Use Information Sheet, Section I to introduce terms and definitions associated with footing forms.

      SUGGESTION:

      - Show students examples of reinforcing materials, vibrator, kerf, boil board, slump, and so on when discussing these terms.

SUGGESTED ACTIVITIES

2. Use Information Sheet, Section II to discuss factors that control the size and shape of footings.

   SUGGESTIONS:

   - Use Supplement #1 to discuss the importance of form design.
   - Give examples of how each of the factors affects the size and shape of the footings.
   - Discuss how form design affects the contractor, the carpenter, and the structure.
   - Discuss the consequences of poorly built forms.

3. Use Information Sheet, Sections III and IV to discuss types of footings and footing styles.

   SUGGESTIONS:

   - Relate types and styles to the factors that control size and shape of footings, emphasizing specific applications.
   - Use Supplement #2 to discuss guidelines for constructing footing forms.

4. Use Information Sheet, Sections V and VI to illustrate the parts of footing and pier footing forms.

   SUGGESTIONS:

   - Use Transparencies #1 - #3 to assist you in illustrating the parts of the different forms.
   - Show students examples of actual forms and have them identify the parts.
   - Take students on a field trip to a construction site at which footing and pier footing forms are being constructed. Have students identify the different types of forms and their parts.
   - Demonstrate and discuss procedures outlined in the job sheets.
   - Before having students complete the job sheets, review laying out footings, transferring grades with hand level and builder's level, and driving stakes to a grade line. Have students practice these tasks, and then have them construct footing forms, using the procedures outlined in Job Sheets #1 through #4.

SUGGESTED ACTIVITIES

III. Unit references

A. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1979.

B. Lewis, Caspar J. *Carpentry*. Albany, New York: Delmar Publishers, Inc., 1984.

C. Ramsey, Charles G., and Harold R. Sleeper. *Architectural Graphics Standards*, 6th ed. New York: John Wiley & Sons, Inc., 1970.

D. Wagner, Willis H. *Modern Carpentry*. South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1976.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — IMPORTANCE OF FORM DESIGN

There are many types of footing form designs and many types of patented forms on the market. Regardless of design or type of form system used or method of erection, certain basic considerations should be followed. Forms must be tight, smooth, free of defects, and properly aligned. Forms must also be strong and properly braced. If the bracing seems inadequate, add more bracing. It is better to overbrace than to lose a form. Various types of manufactured braces, clamps, and ties are available to help the carpenter build strong forms. Forms and accessories can also be purchased from manufacturers, and there are some suppliers that rent or lease forms.

Form design is very important because a good carpenter is economical and reuses the forms. To speed erection and stripping the carpenter should use form panels whenever possible; and to prevent damage to the panels so that they may be reused, the carpenter should use the minimum number of nails necessary to erect the panels.

After the panels are removed, a little time should be devoted to the maintenance of the forms. Clean the forms thoroughly, make repairs as necessary, coat each form with form oil, stock neatly, and protect from the weather.

SUGGESTED ACTIVITIES

SUPPLEMENT #2 — GUIDELINES FOR CONSTRUCTING FOOTING FORMS

Design — Become familiar with local building codes; check soil conditions; read plans to determine type, style, and size of footings

Layout — Read plans; determine location; accurately measure and lay out lines; set batter boards; establish lines and grades

Excavation or fill — Determine if excavation or fill is necessary; excavate or fill according to specifications

Compaction — Determine amount of fill and if compaction is necessary; compact fill according to specifications

Forming — Recheck lines and elevations; transfer lines and elevations to form stakes; build and set forms

Fine grading — Remove loose dirt and debris; add fill if necessary to bring grade to correct elevation; compact if necessary; install vapor barrier as specified

Reinforcing — Check plans and specifications for type, size, spacing, and amount of reinforcing steel; install reinforcing as specified

Ordering concrete — Calculate amount of concrete needed; check plans and specifications for type of concrete; order concrete

(NOTE: Concrete is calculated and ordered to the next 1/4 cubic yard. Strength, slump, and admixtures are found in the specifications.)

EXAMPLE: 4 1/2 cubic yards, 2500#, 5-inch slump, with air-entraining admixture

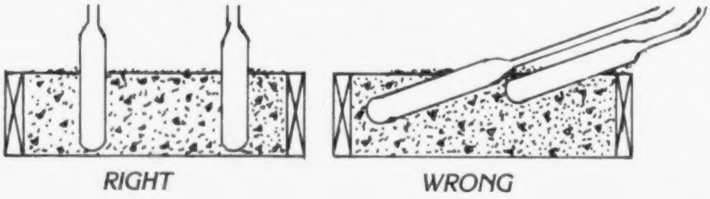
Placing concrete — Use any acceptable method to place concrete in its final location; never let concrete free drop over 5 feet

EXAMPLES: Place with chutes, conveyors, elephant trunks, tremies, concrete pumps, or concrete buckets and hoisting equipment.

Vibrating concrete — Use vibrator to consolidate and fill voids; never try to move concrete with vibrator; do not allow concrete to flow laterally more than 2 to 3 feet

(NOTE: Overvibrating increases pressure which can break or blow out the forms and can cause separation in the concrete.)

EXAMPLE:

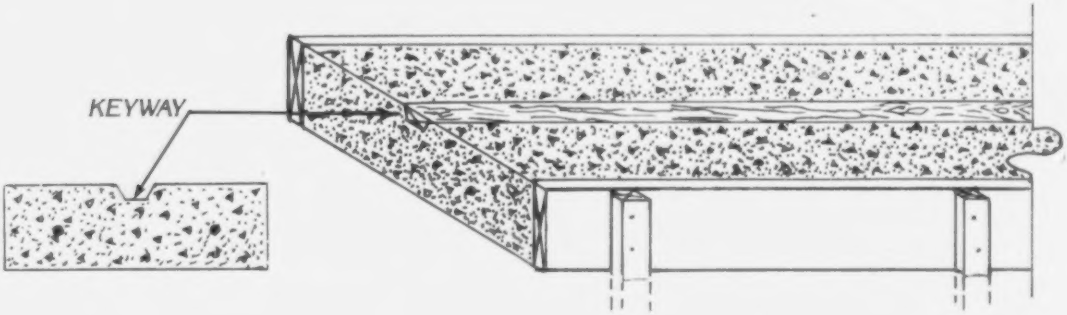


SUPPLEMENT #2

Striking off concrete — Surface or rod surface of concrete flush with top of forms or grade line; install keyway strip in footing if necessary

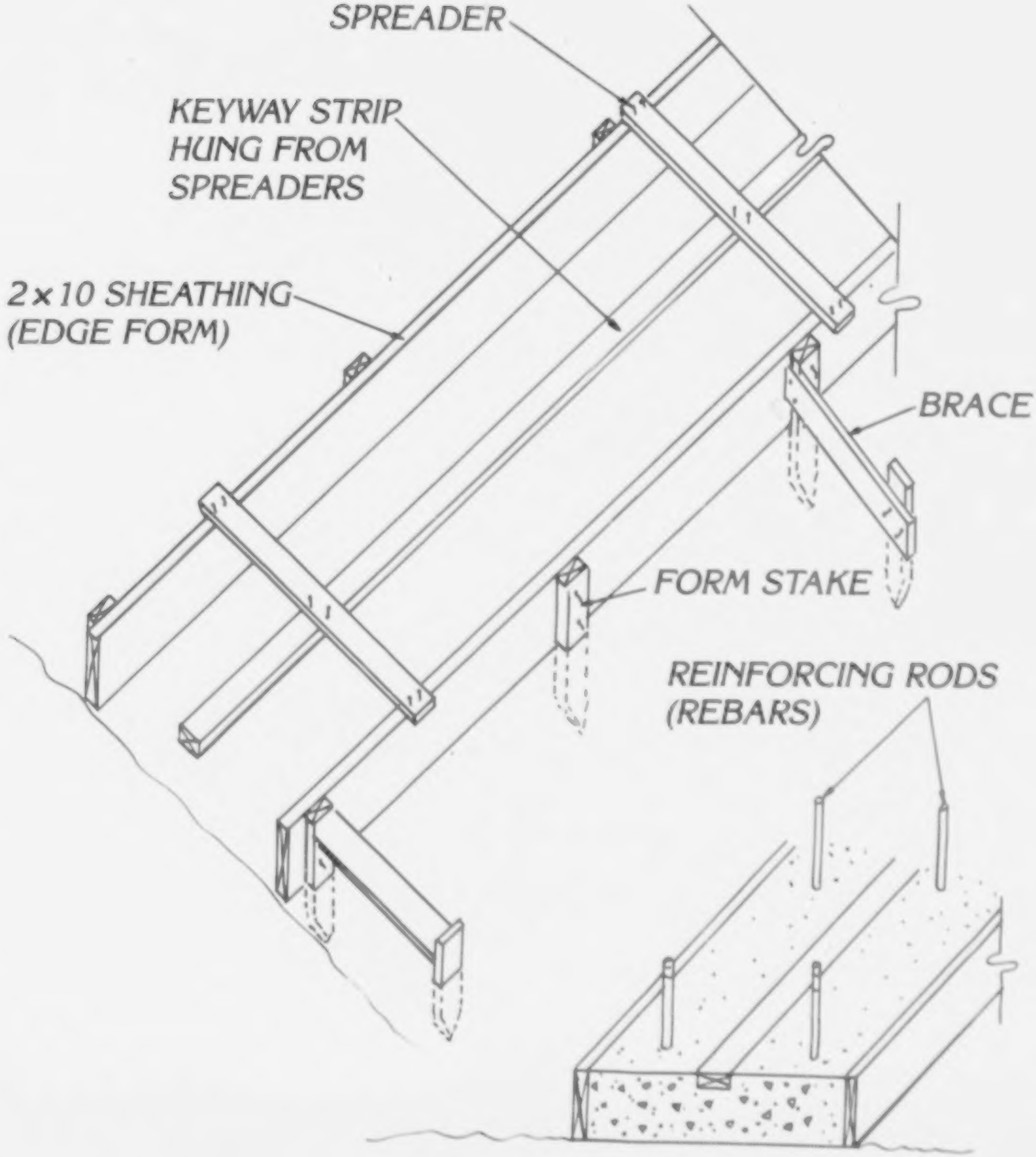
(NOTE: A keyway strip is installed by pressing a beveled 2×4 into the surface of the concrete before it sets.)

EXAMPLE:

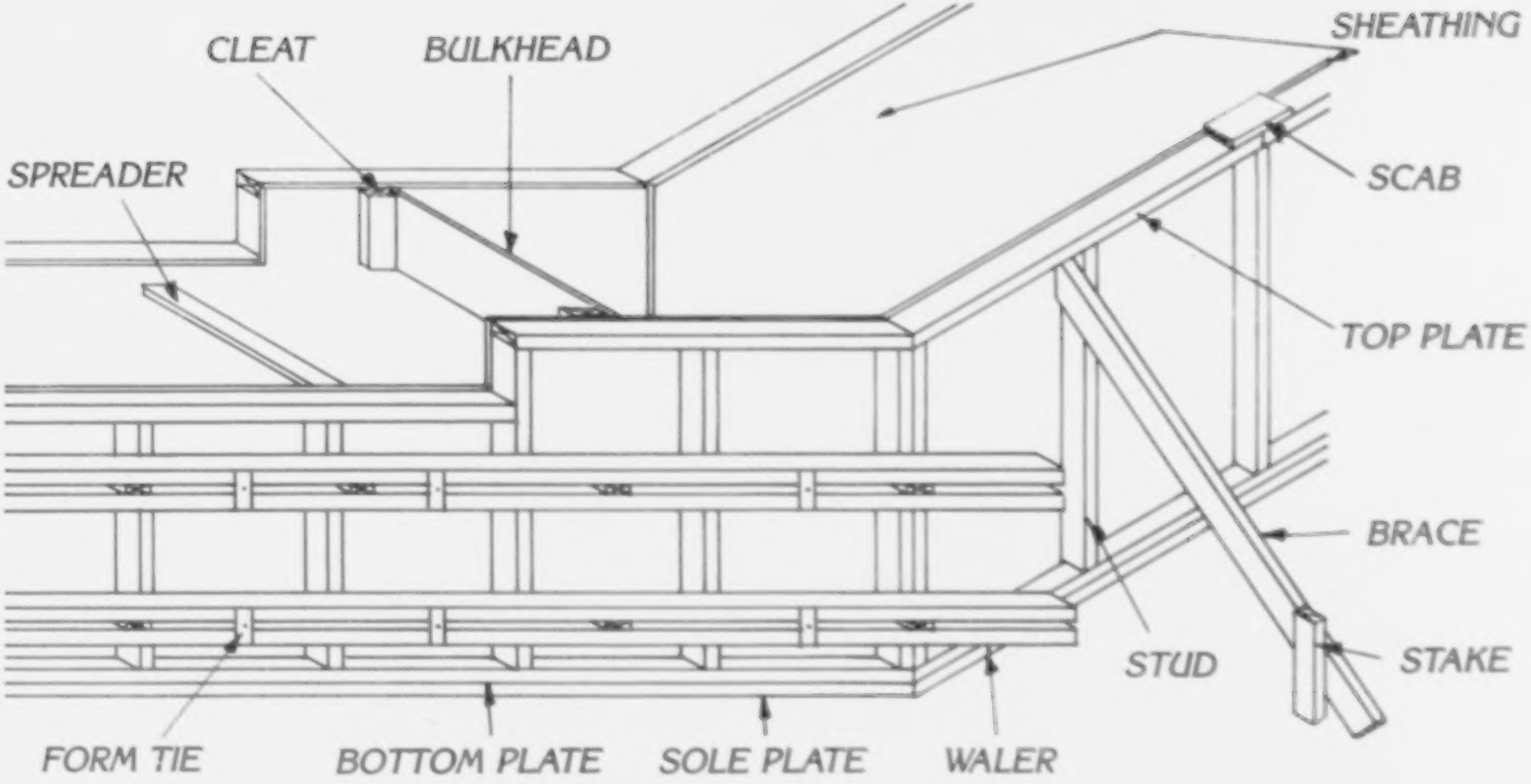


Finish Concrete — Strike off or rod surface of concrete flush with top of forms or grade line; install keyway strip in footing if necessary

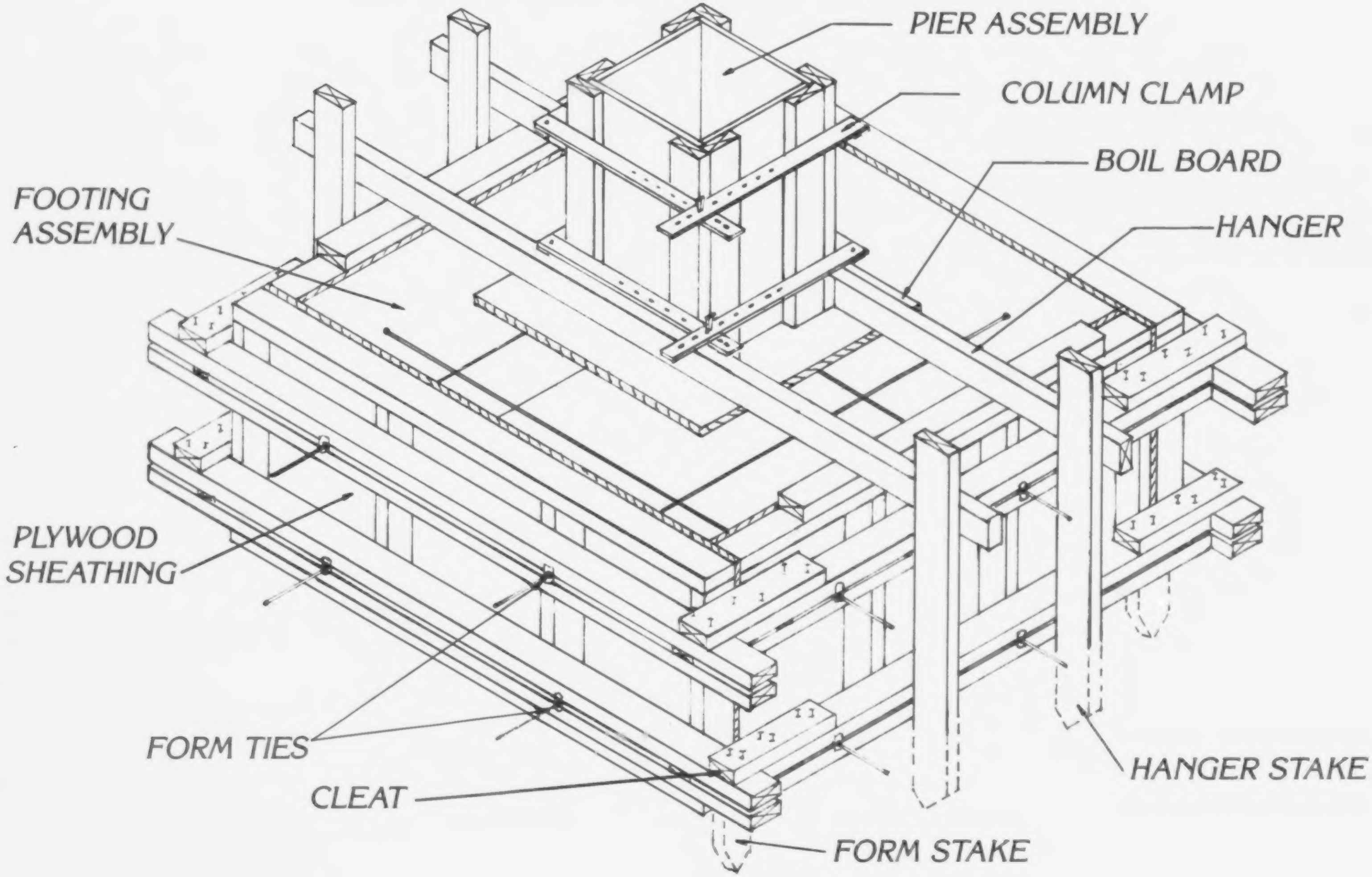
Parts of a Spread Footing


SPREADER
KEYWAY STRIP HUNG FROM SPREADERS
2×10 SHEATHING (EDGE FORM)
BRACE
FORM STAKE
REINFORCING RODS (REBARS)

Parts of a Step Footing Form


SHEATHING
CLEAT
BULKHEAD
SPREADER
SCAB
TOP PLATE
BRACE
STUD
STAKE
FORM TIE
BOTTOM PLATE
SOLE PLATE
WALER

Parts of a Pier Footing Form


PIER ASSEMBLY
COLUMN CLAMP
BOIL BOARD
HANGER
FOOTING ASSEMBLY
PLYWOOD SHEATHING
FORM TIES
CLEAT
FORM STAKE
HANGER STAKE

FOOTING FORMS
UNIT II

INFORMATION SHEET

I. Terms and definitions

  A. Footing — Enlarged area at base of a wall, pier, or column; used to distribute weight of superstructure

  B. Excavation — Cavity or depression made by removal of dirt by cutting, digging, or scooping

  C. Compaction — Reduction in bulk of fill

  D. Elevation — Given grade

  E. Reinforcing — Steel used in concrete to increase tensile strength of concrete

  EXAMPLES: Wire mesh, rebars

  F. Slump — Consistency (wetness) of concrete

  G. Air-entraining admixture — Agent that incorporates microscopic air bubbles into concrete to improve workability and resistance to freezing, thawing, and scaling

  H. Vibrator — Power tool used to consolidate concrete

  I. Float or rod — Tool or process used to finish the surface of concrete

  J. Kerf — Shallow saw-cut in which to fit line to hold it in place

  K. Boil board — Part of a form that prevents concrete from running up and out of form

  L. Duplex nails (double headed) — Nail used in forming and designed for easy removal

II. Factors that control the size and shape of footings

  A. Building codes

  B. Climate

  C. Size of structure

  D. Soil conditions

  E. Type of material used

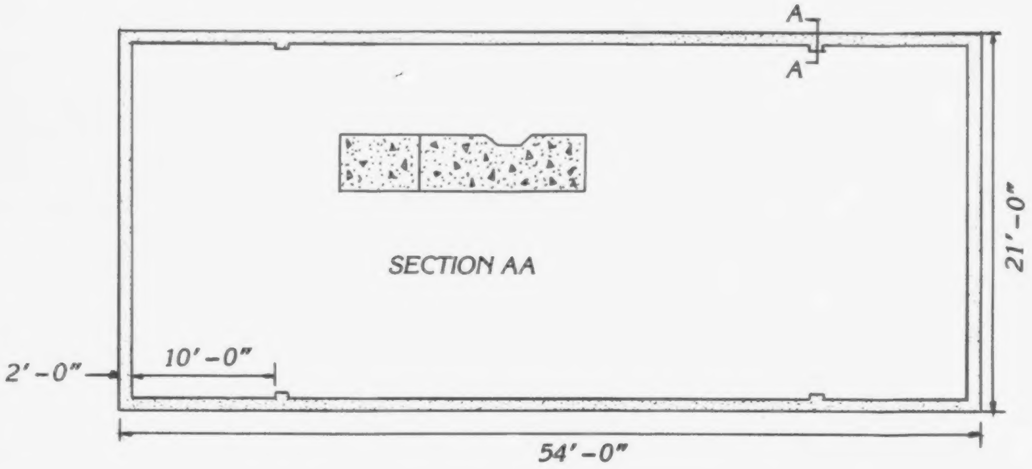
INFORMATION SHEET

III. Types of footings (Figures 1-8)

A. Continuous

EXAMPLE:

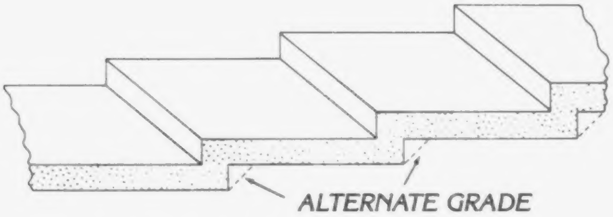
FIGURE 1


A
A
SECTION AA
21'-0"
2'-0"
10'-0"
54'-0"

B. Stepped continuous

EXAMPLE:

FIGURE 2

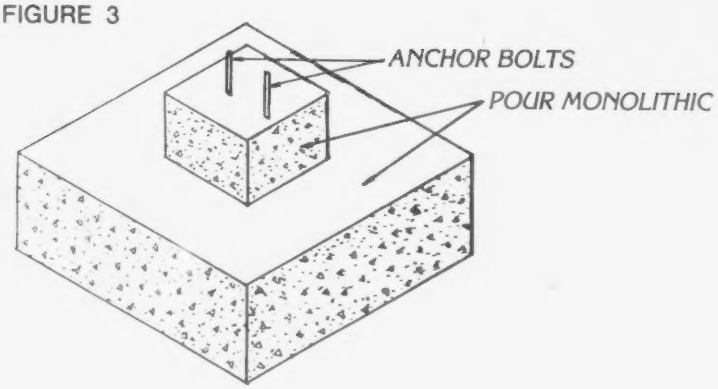

ALTERNATE GRADE

INFORMATION SHEET

C. Pier

EXAMPLE:

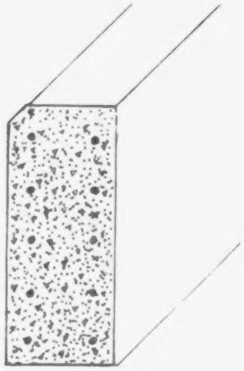
FIGURE 3


ANCHOR BOLTS
POUR MONOLITHIC

D. Grade beam

EXAMPLE:

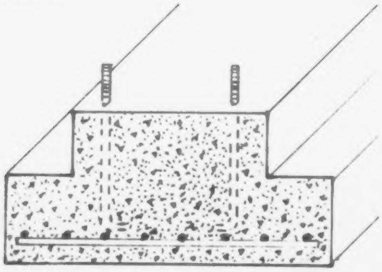
FIGURE 4



E. Spread

EXAMPLE:

FIGURE 5

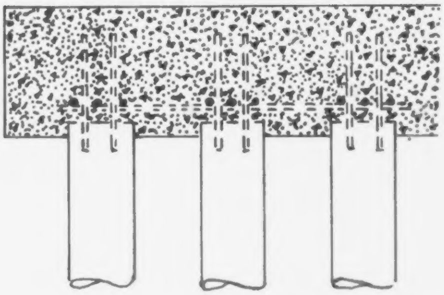


INFORMATION SHEET

F. Pile cap

EXAMPLE:

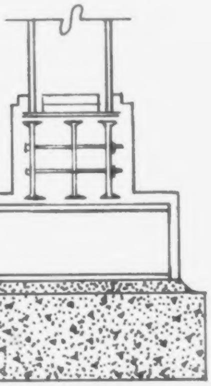
FIGURE 6



G. Grillage

EXAMPLE:

FIGURE 7

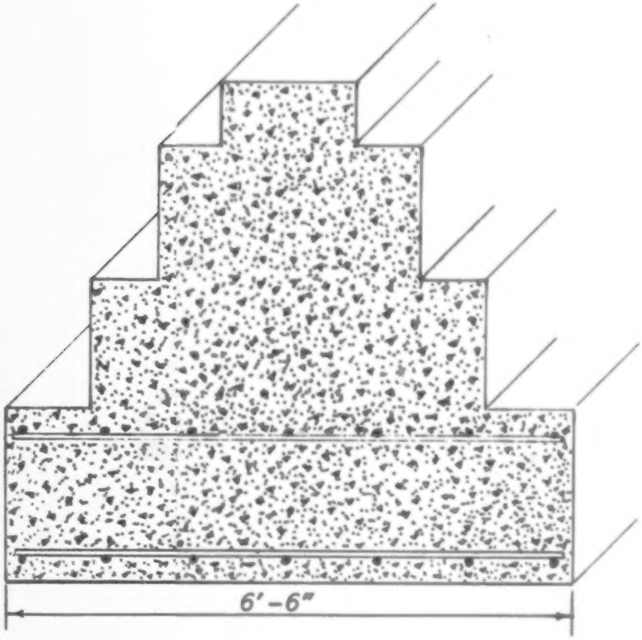


INFORMATION SHEET

H. Mass concrete footing

EXAMPLE:

FIGURE 8

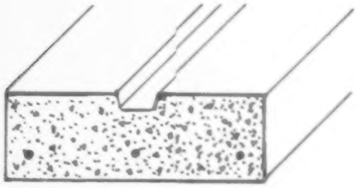


IV. Footing styles (Figures 9-12)

A. Square

EXAMPLE:

FIGURE 9

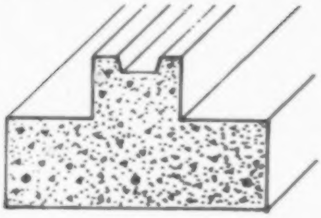


INFORMATION SHEET

B. "T"

EXAMPLE:

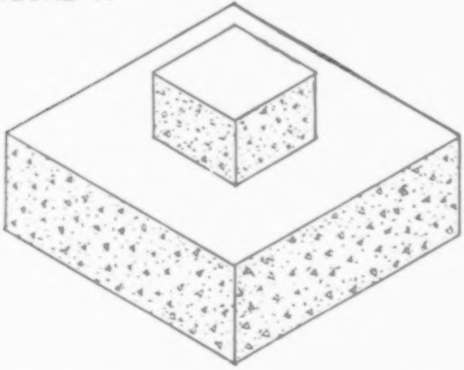
FIGURE 10



C. Pier

EXAMPLE:

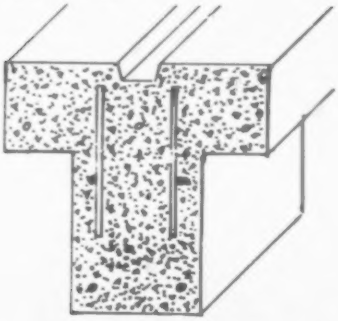
FIGURE 11



D. Pier and beam

EXAMPLE:

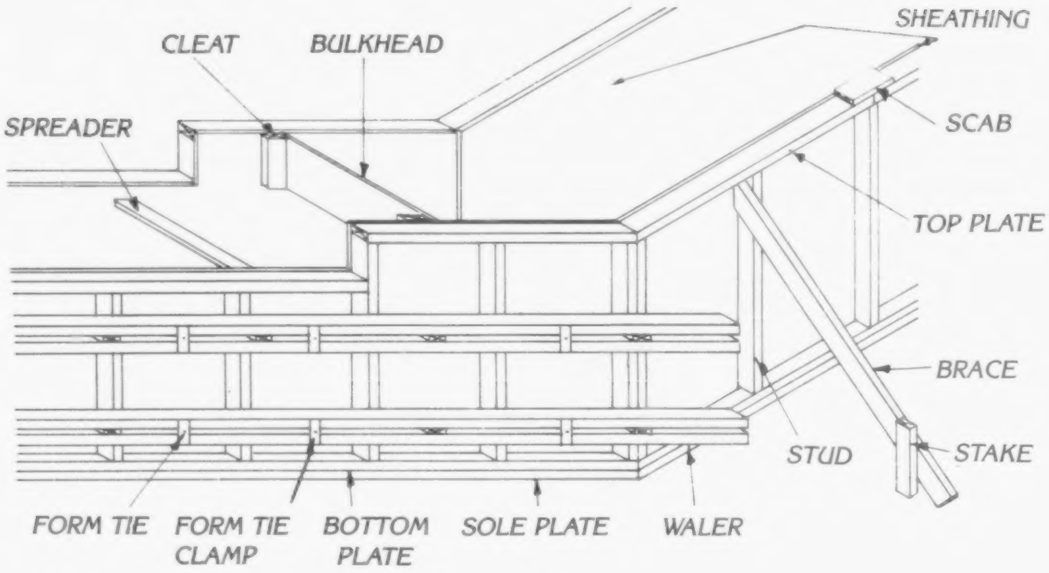
FIGURE 12



INFORMATION SHEET

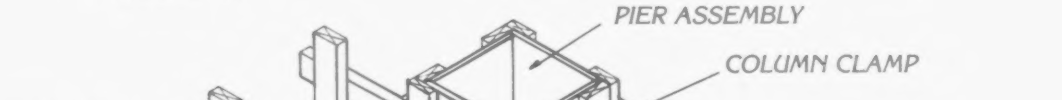
V. Parts of a footing form (Figure 13)

FIGURE 13


SHEATHING
CLEAT
BULKHEAD
SPREADER
SCAB
TOP PLATE
BRACE
STUD
STAKE
FORM TIE
FORM TIE CLAMP
BOTTOM PLATE
SOLE PLATE
WALER

VI. Parts of a pier footing form (Figure 14)

FIGURE 14


PIER ASSEMBLY
COLUMN CLAMP
FOOTING ASSEMBLY
BOIL BOARD
HANGER
PLYWOOD SHEATHING
WALERS
FORM TIES
HANGER STAKE
CLEAT
FORM STAKE

FOOTING FORMS
UNIT II

JOB SHEET #1 — SET FORMS FOR A CONTINUOUS FOOTING

I. Tools and materials

  A. Tools

    1. Power handsaw and extension cord
    2. Handsaw
    3. Claw hammer
    4. Sledgehammer
    5. One-hundred-foot tape
    6. Folding rule or steel tape
    7. Hand level
    8. String line
    9. Builder's level
    10. Plumb bob
    11. Large brush, spray can, roller, or mop for applying form oil

  B. Materials

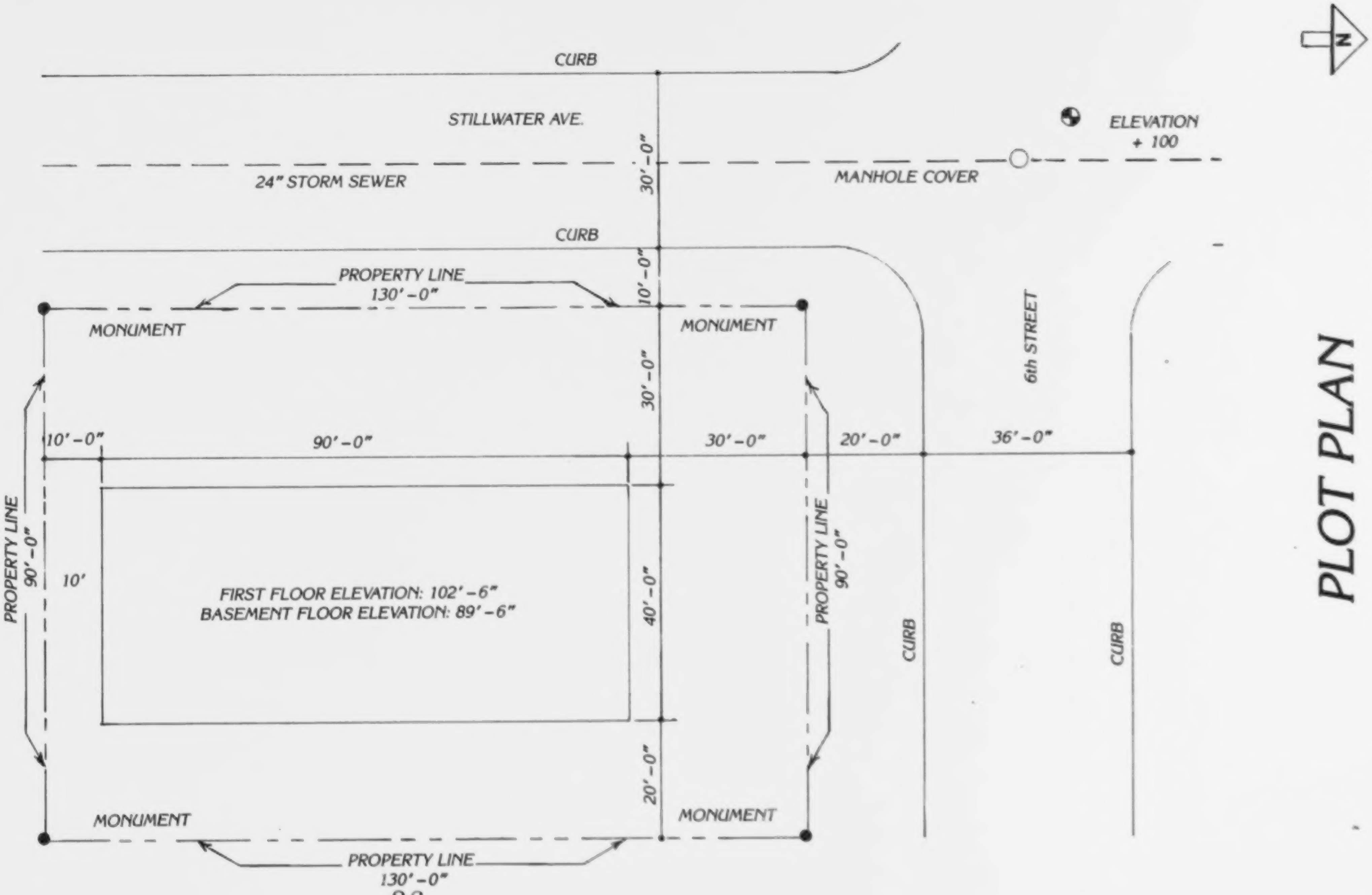
    1. Form stakes, 2″ × 4″ × 18″
    2. Form boards, 2″ × 12″ × 520′
    3. Corner and hub stakes, 2″ × 2″ × 1′
    4. Precut spreaders, 2″ × 8″ × 3′
    5. 1×4s for cleats
    6. 8d and 16d duplex nails
    7. Form oil
    8. Plans

      (NOTE: The plans listed below are shown on the next three pages.)

      a. Plot Plan, Sheet #1
      b. Batter Board Layout Plan, Sheet #2
      c. Foundation Plan, Sheet #3

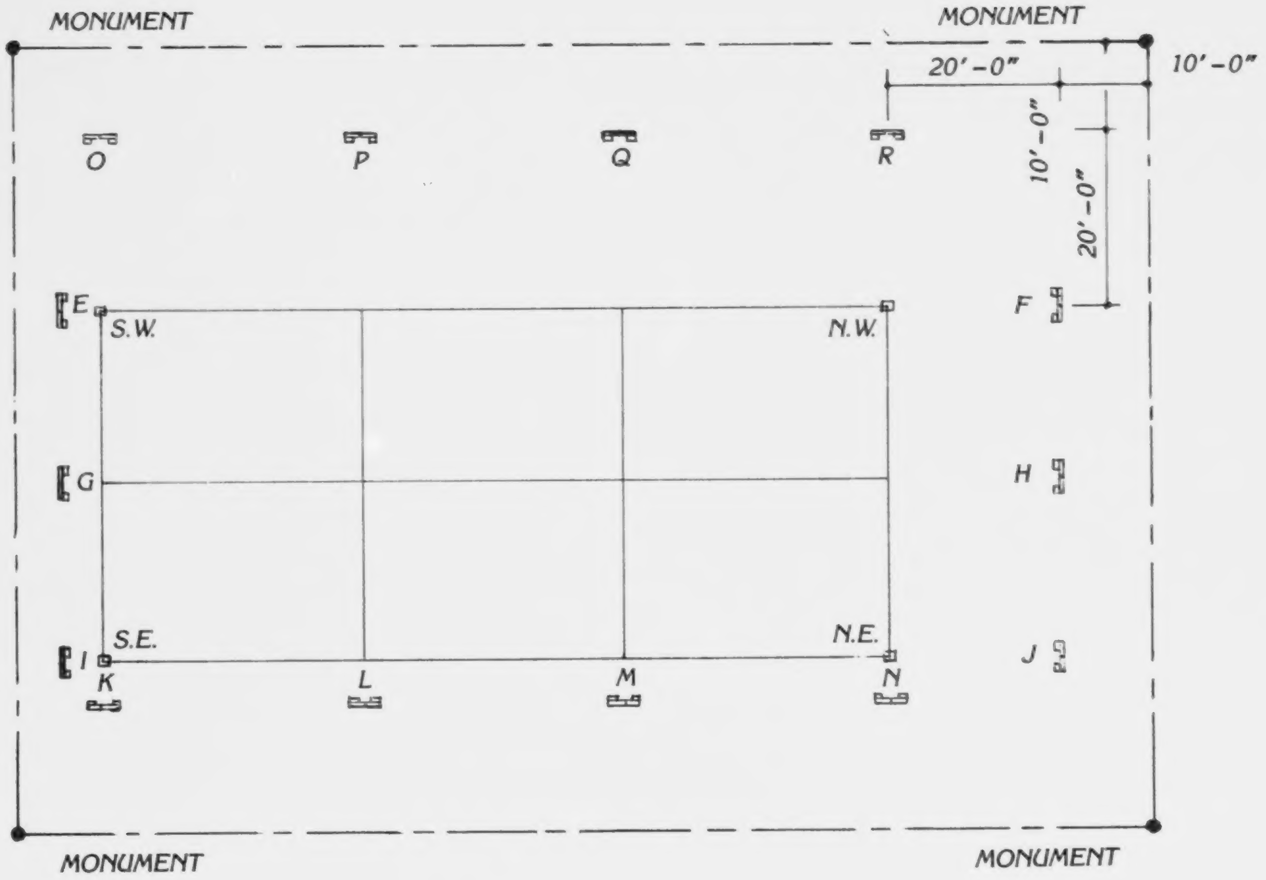
PLOT PLAN

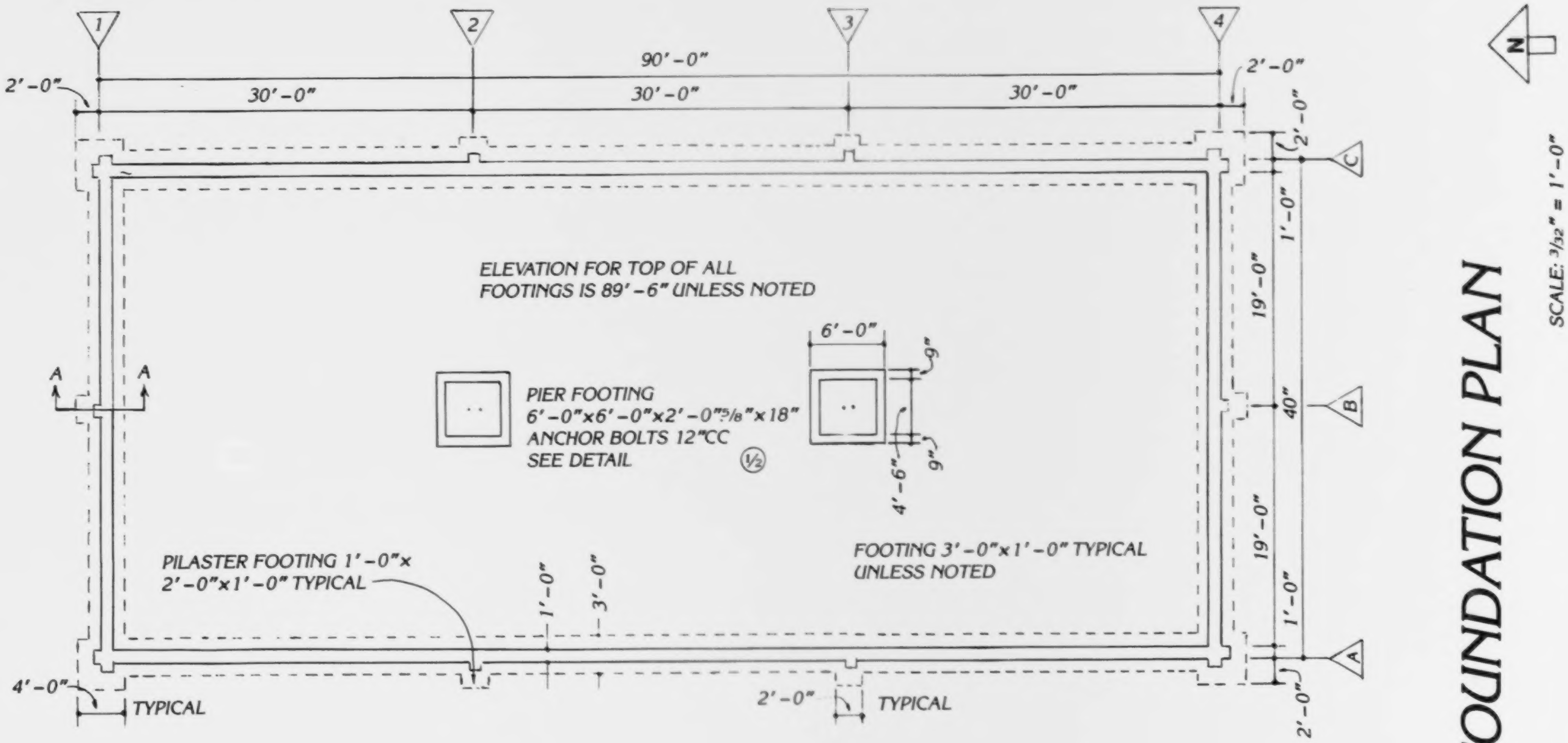
SCALE: 1" = 20'-0"


CURB
STILLWATER AVE.
ELEVATION
+ 100
24" STORM SEWER
MANHOLE COVER
30'-0"
CURB
N
PROPERTY LINE
130'-0"
10'-0"
MONUMENT
MONUMENT
30'-0"
6th STREET
10'-0"
90'-0"
30'-0"
20'-0"
36'-0"
PROPERTY LINE
90'-0"
10'
FIRST FLOOR ELEVATION: 102'-6"
BASEMENT FLOOR ELEVATION: 89'-6"
40'-0"
PROPERTY LINE
90'-0"
CURB
CURB
20'-0"
MONUMENT
MONUMENT
PROPERTY LINE
130'-0"

BATTER BOARD LAYOUT PLAN

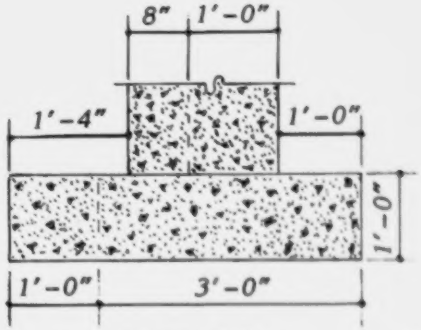
SCALE: 1' = 20'-0"


MONUMENT
MONUMENT
20'-0"
10'-0"
10'-0"
20'-0"
O
P
Q
R
E
S.W.
N.W.
F
G
H
S.E.
N.E.
I
J
K
L
M
N
MONUMENT
MONUMENT


1
2
3
4
90'-0"
2'-0"
30'-0"
30'-0"
30'-0"
2'-0"
2'-0"
C
1'-0"
19'-0"
40"
B
19'-0"
1'-0"
A
2'-0"
ELEVATION FOR TOP OF ALL
FOOTINGS IS 89'-6" UNLESS NOTED
6'-0"
9"
9"
4'-6"
PIER FOOTING
6'-0"x6'-0"x2'-0"5/8"x18"
ANCHOR BOLTS 12"CC
SEE DETAIL ½
A
A
PILASTER FOOTING 1'-0"x
2'-0"x1'-0" TYPICAL
1'-0"
3'-0"
FOOTING 3'-0"x1'-0" TYPICAL
UNLESS NOTED
4'-0"
TYPICAL
2'-0"
TYPICAL
N

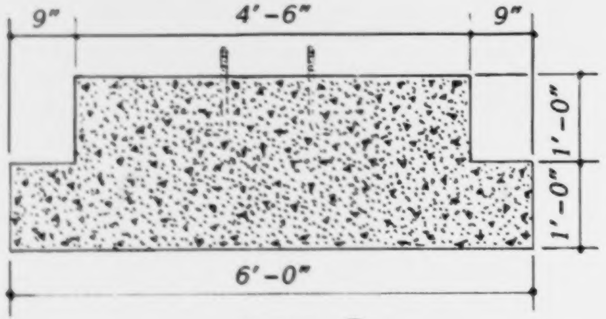
FOUNDATION PLAN

SCALE: 3/32" = 1'-0"


8"
1'-0"
1'-4"
1'-0"
1'-0"
1'-0"
3'-0"

SECTION AA

SCALE: ½" = 1'-0"


9"
4'-6"
9"
1'-0"
1'-0"
6'-0"

DETAIL ½

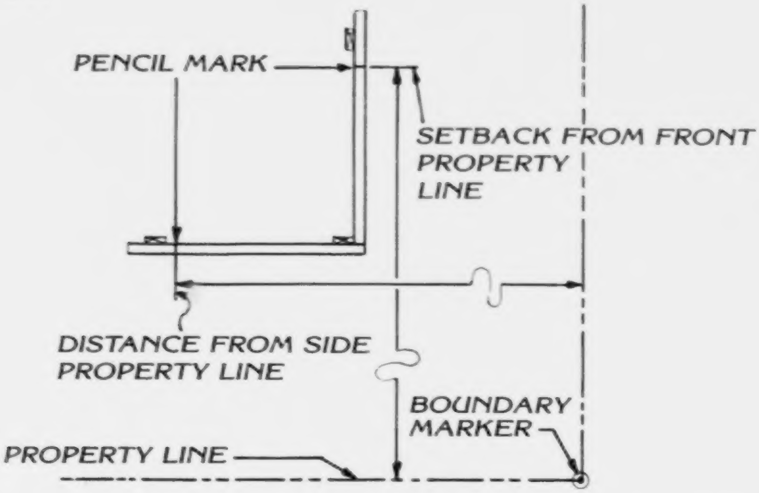
JOB SHEET #1

II. Procedure

A. Reestablish building lines

1. Measure from property line to ledger board on batter boards; mark top edge of ledger board at designated distance (Figure 14)

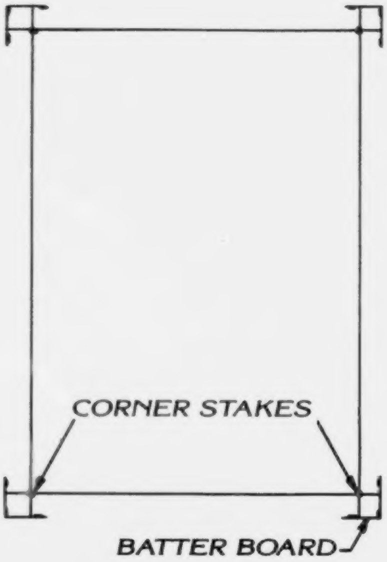
FIGURE 14


PENCIL MARK
SETBACK FROM FRONT PROPERTY LINE
DISTANCE FROM SIDE PROPERTY LINE
BOUNDARY MARKER
PROPERTY LINE

2. Continue this procedure until all building lines have been reestablished

3. Locate building lines by attaching string to nails driven into marks on ledger boards, and pulling string taut between these points (Figure 15)

FIGURE 15

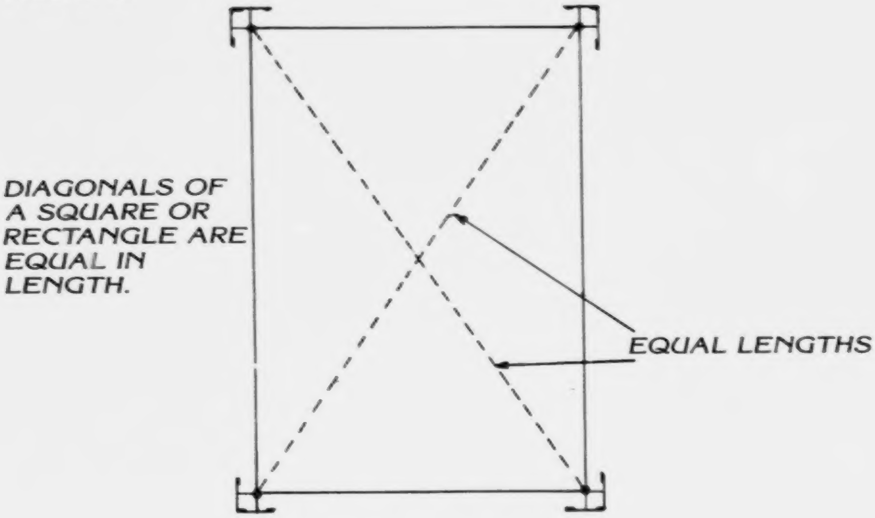

CORNER STAKES
BATTER BOARD

JOB SHEET #1

4. Square corners of building lines, using diagonal method or 3-4-5 method

   a. Diagonal method (Figure 16)

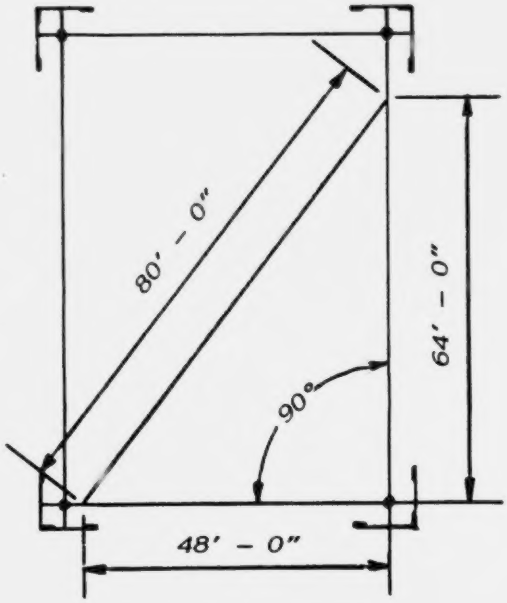
FIGURE 16


DIAGONALS OF A SQUARE OR RECTANGLE ARE EQUAL IN LENGTH.
EQUAL LENGTHS

   b. 3-4-5 method (Figure 17)

   (NOTE: Any multiple of 3-4-5 may be used, such as 6-8-10, 9-12-15, or 48-64-80.)

FIGURE 17


80' – 0"
64' – 0"
90°
48' – 0"

JOB SHEET #1

5. Shift strings on ledger boards until building-line corners are square

6. After exact building lines have been established and squared, saw a kerf or set a nail in each ledger board at the exact location to keep line from shifting

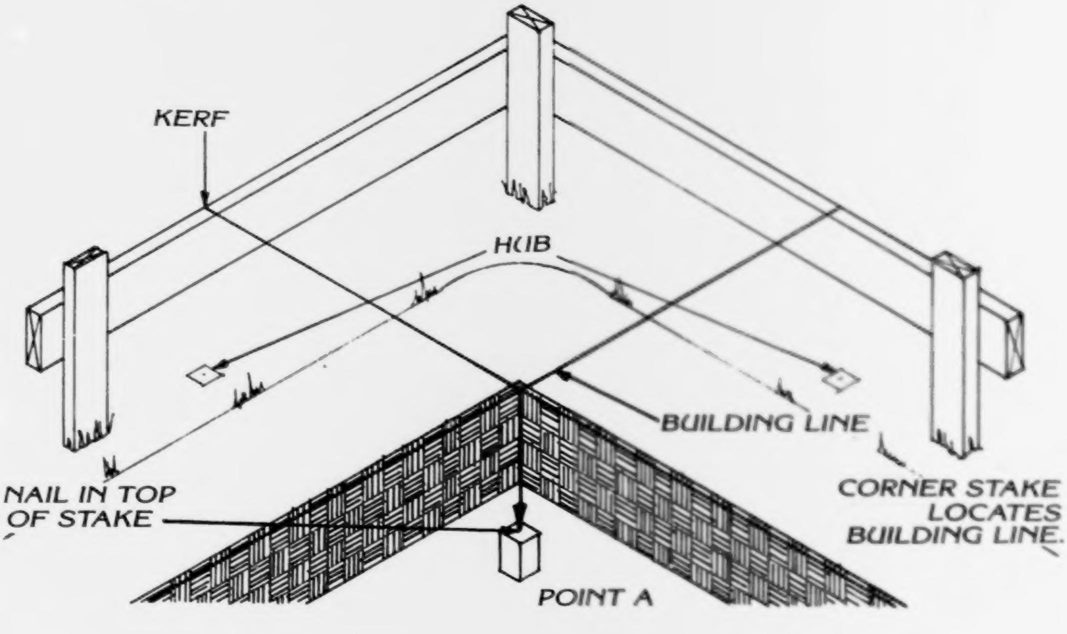
7. Locate and drive corner stakes at building lines to establish grade (See Figure 18)

   a. Plumb down from intersection of lines at each corner of building lines

   b. Drive corner stakes directly under plumb bob

   c. Drive a nail in top of each stake at exact point where plumb bob touches it; remove plumb bob

FIGURE 18



B. Transfer bench mark to bottom of excavation

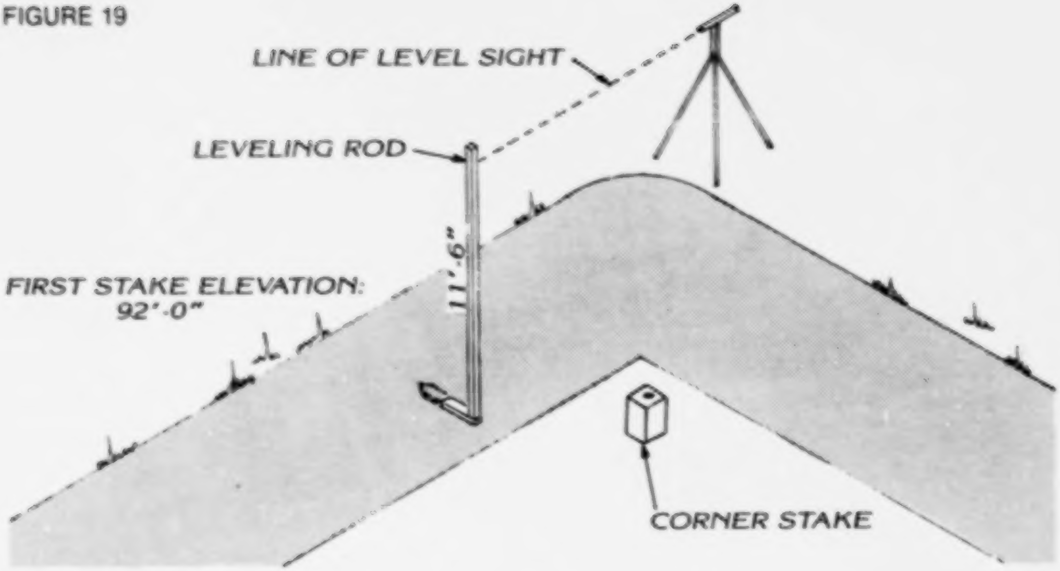
1. Set up builder's level

2. Establish height of instrument (HI) from bench mark; see Plot Plan, Sheet #1

EXAMPLE: Assume an HI of 103'6"; from the plot plan, the basement-floor elevation is 89'6" from 103'6", which is 14'0"; this is the figure to read on the leveling rod; however, the rod is only 12' long, so drive a stake in the bank reading 11'6" on the leveling rod; this will be at elevation 92'0" (See Figure 19).

JOB SHEET #1

FIGURE 19


LINE OF LEVEL SIGHT
LEVELING ROD
11'-6"
FIRST STAKE ELEVATION: 92'-0"
CORNER STAKE

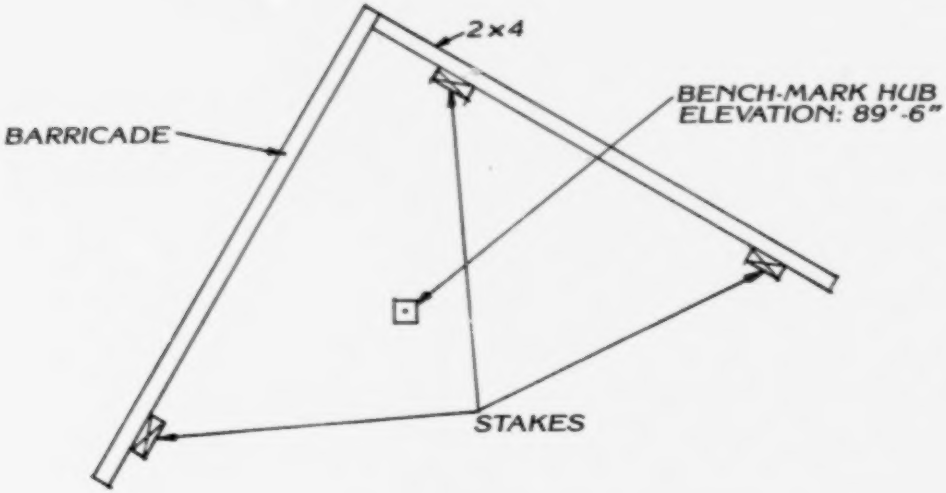
3. Move builder's level to bottom of excavation and set it up

4. Pick up HI from stake at elevation on leveling rod and set another hub stake, with top of stake at basement-floor elevation

   (NOTE: The bench-mark hub should be placed in a central location and out of the areas of traffic. Build a barricade around it if necessary. See Figure 20.)

5. Set all corner stakes at bench-mark elevation (Figure 20)

FIGURE 20


2×4
BENCH-MARK HUB ELEVATION: 89'-6"
BARRICADE
STAKES

JOB SHEET #1

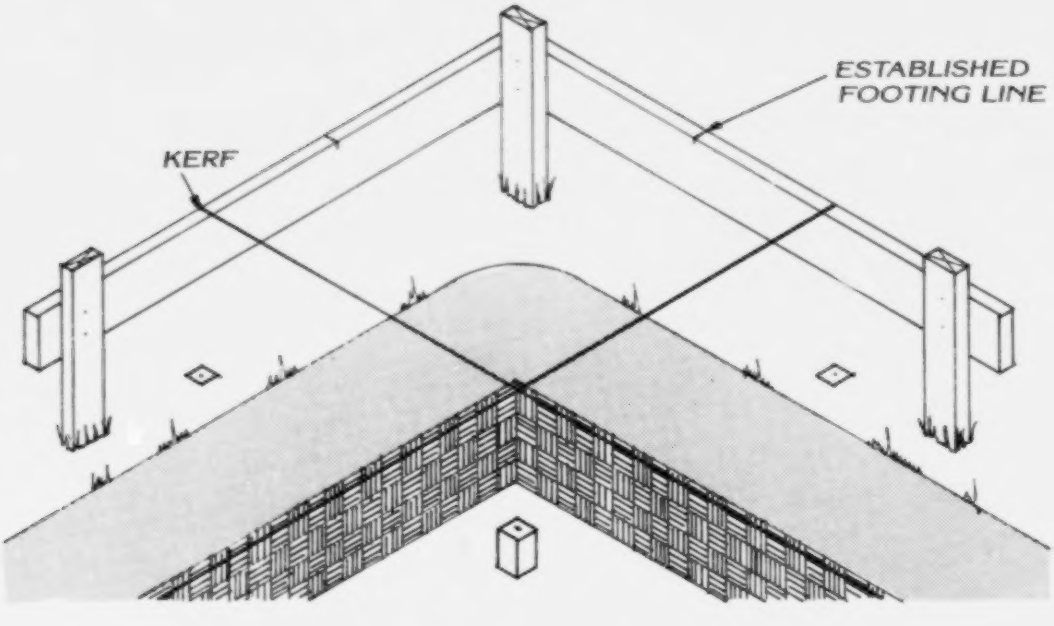
C. Establish footing lines

1. Determine from plans how far outside of building lines to construct forms

   (NOTE: Since the footings are 3 feet wide and the finished walls are 1-foot thick, the footing lines will have to be set 12 inches both ways from the building line, plus another 1½ inches to allow for the thickness of the forms.)

2. Measure over 13½ inches from each kerf in ledger boards; mark top edges of ledger boards at this point to establish outside footing lines (Figure 21)

FIGURE 21



3. Drive a nail at these locations to help distinguish footing line from building line

4. Move string line from building line and stretch from one footing-line nail to the next, continuing around outside footing of proposed building

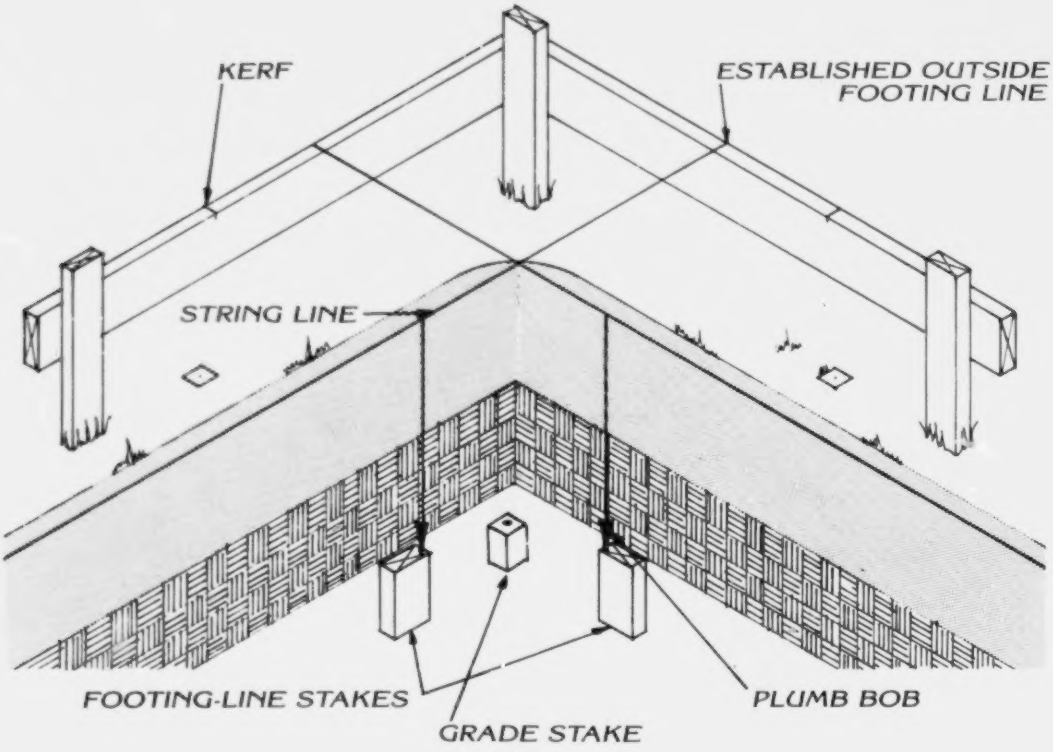
D. Set outside forms

(NOTE: Refer to the plans when necessary to check dimensions.)

JOB SHEET #1

1. Use plumb bob to locate position of footing-line stakes for each corner of building (Figure 22)

FIGURE 22


KERF
ESTABLISHED OUTSIDE FOOTING LINE
STRING LINE
FOOTING-LINE STAKES
PLUMB BOB
GRADE STAKE

2. Move plumb bob; drive stakes straight, leaving them a little higher than bench-mark hub stakes
3. Recheck stakes with plumb bob after they are set
4. Transfer grade from grade stakes to outside footing-line stakes
5. Attach line to stakes
6. String line from one line stake to one on opposite end of footing, centering line on the grade that was transferred to those stakes
7. Lay out forms end to end along the proposed footing line
8. Drive all outside footing stakes, spacing them approximately 4 feet apart

JOB SHEET #1

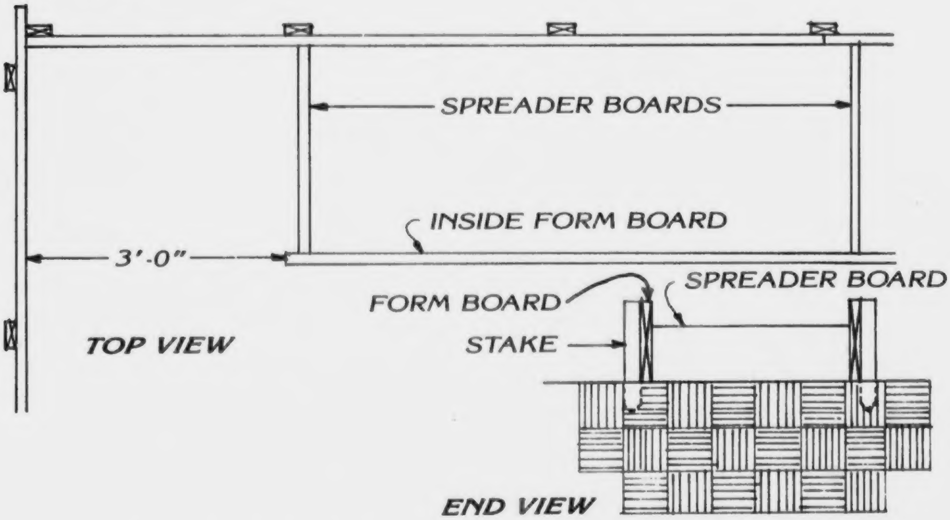
9. Nail form boards to grade, checking alignment of boards by using plumb bob attached at different points on string line

E. Set inside forms

  1. Set spreader boards on edge against outside forms, and then set inside form boards against spreader boards (Figure 23)

     (NOTE: Form oil must be applied either before or after installation.)

FIGURE 23



  2. Set inside footing-form stakes, spacing them approximately 4 feet apart and driving them straight down so that there is no pressure exerted against inside form, which would move outside form out of line

  3. Nail inside form boards to grade, checking alignment of boards by using plumb bob attached at different points along string line

  4. Nail cleats across top of form (See Figure 24)

  5. Install dowel rods if specified in the plans

     a. Nail 2×4 across cleats to support dowel rods

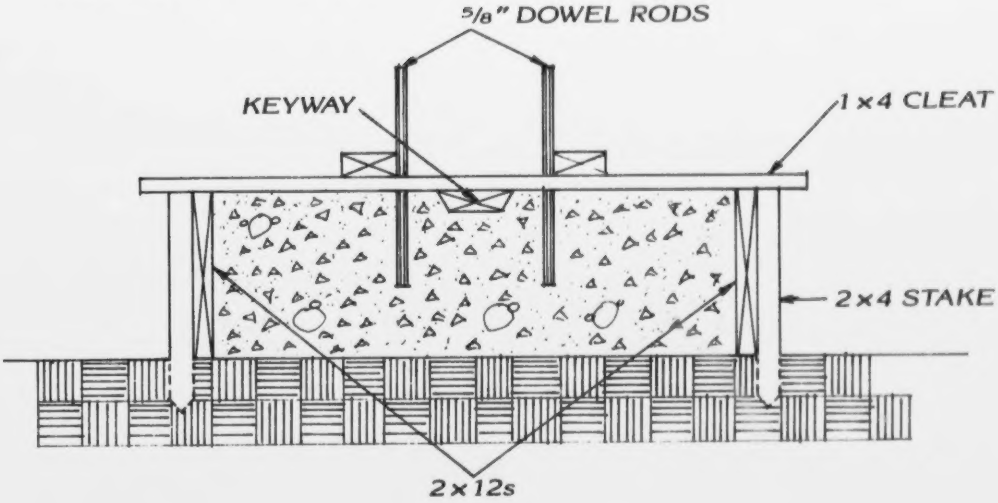
     b. Fasten dowels to 2×4

     c. Nail keyway to cleats if specified (See Figure 24)

        (NOTE: For ease of placing concrete, dowels and keyway may be installed after concrete is in place.)

JOB SHEET #1

FIGURE 24


5/8" DOWEL RODS
KEYWAY
1 x 4 CLEAT
2 x 4 STAKE
2 x 12s

F. Recheck forms for alignment

(NOTE: The tops of the stakes may be cut off flush with the top of the form for ease of finishing the surface of the concrete.)

G. Clean up area and put away tools and materials

FOOTING FORMS
UNIT III

JOB SHEET #2 — CONSTRUCT AND SET FORMS FOR A PILE CAP 4'-0" 8'-0"

I. Tools and materials

   A. Power handsaw and extension cord

   B. Crosscut handsaw

   C. Claw hammer

   D. Sledge hammer

   E. One-hundred-foot steel tape

   F. Folding rule or steel tape

   G. Hand level

   H. Builder's level

   I. Electric drill motor and drills

   J. Chalk line

   K. Ten-inch adjustable wrench

   L. Plumb bob

   M. String line

   N. Plans

   O. Stakes

   P. 3/4" plywood sheathing

   Q. 2×6s for spreaders

   R. Form ties

   S. 2×4s for braces, studs, plates, and walers

   T. 2×4 wedges

   U. Nails

      1. 8d and 16d duplex

      2. 6d, 8d, and 16d common

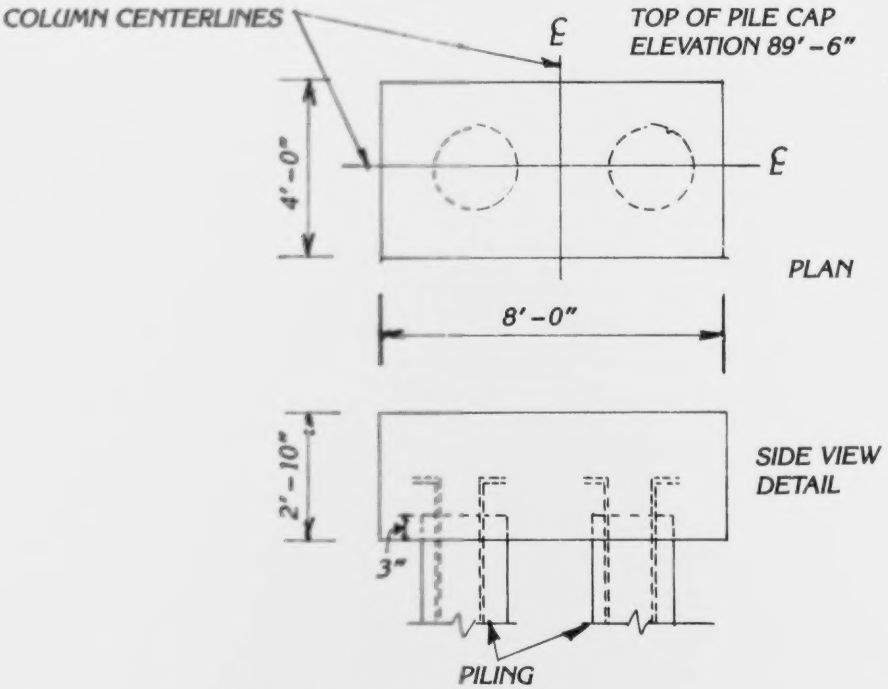
   V. Form oil

JOB SHEET #2

II. Procedure

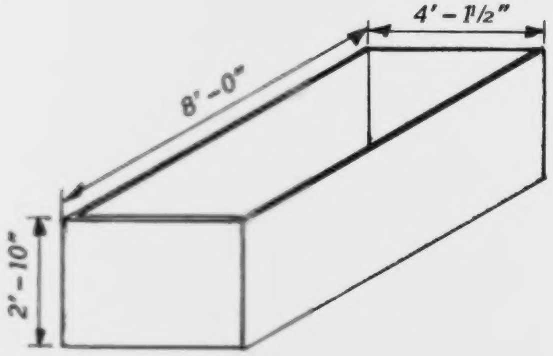
A. Determine the size of the form (Figure 23)

FIGURE 23


COLUMN CENTERLINES
℄
TOP OF PILE CAP
ELEVATION 89'-6"
℄
4'-0"
PLAN
8'-0"
2'-10"
SIDE VIEW
DETAIL
3"
PILING

B. Make material cut list (Figure 24)

FIGURE 24



JOB SHEET #2

C. Build forms

1. Using cut list as a guide, cut studs and sheathing to length and width

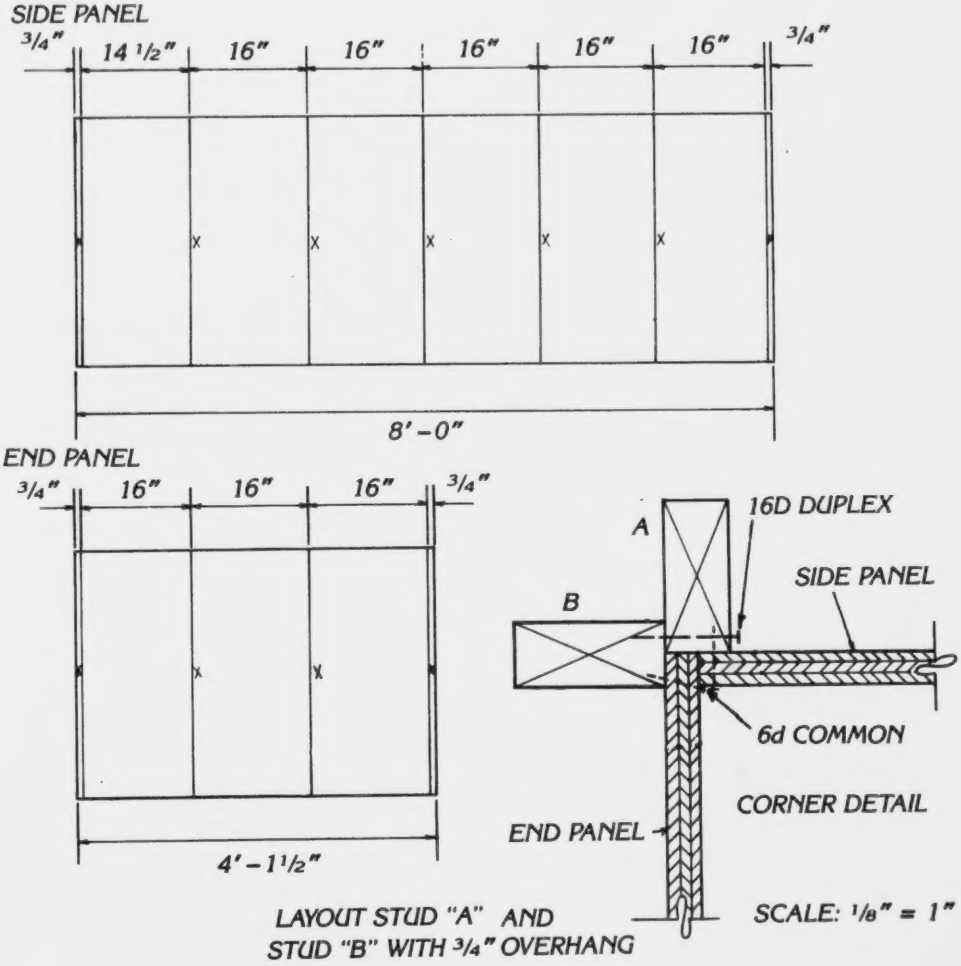
2. Lay out stud spacing (Figure 25)

    a. Lay out first and last studs on all four panels

       (NOTE: Refer to corner detail in Figure 25 for stud overhang on specific panels.)

    b. Divide remaining distance into equal spaces not exceeding 16 inches on center

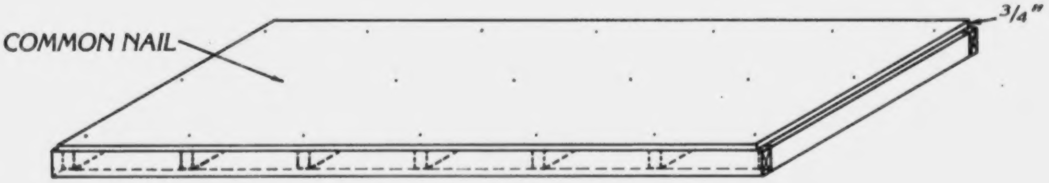
FIGURE 25


SIDE PANEL
3/4"
14 1/2"
16"
16"
16"
16"
16"
3/4"
8'-0"
END PANEL
3/4"
16"
16"
16"
3/4"
4'-1 1/2"
A
B
16D DUPLEX
SIDE PANEL
6d COMMON
CORNER DETAIL
END PANEL
LAYOUT STUD "A" AND
STUD "B" WITH 3/4" OVERHANG
SCALE: 1/8" = 1"

JOB SHEET #2

3. Nail sheathing to studs of all four panels (Figure 26)

FIGURE 26



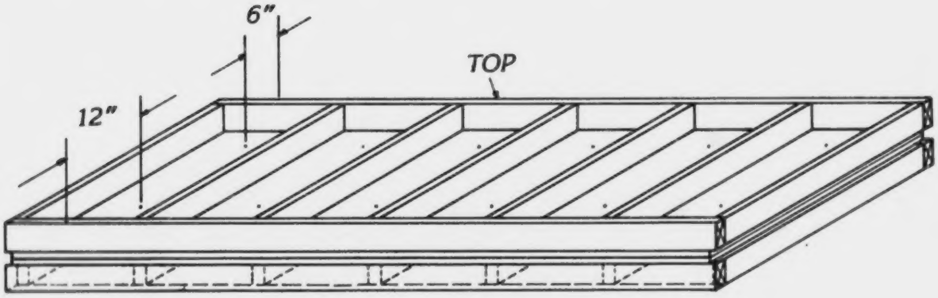
SCALE: 1/2" = 1'-0"

(NOTE: The nailing pattern shown in Figure 26 is sufficient for one or two pours. If forms are used on more than two pours, they should be nailed at 1-foot centers.)

4. Drill holes for form ties

   a. Stack one form on top of another face to face so that two forms can be drilled at the same time (Figure 27)

FIGURE 27

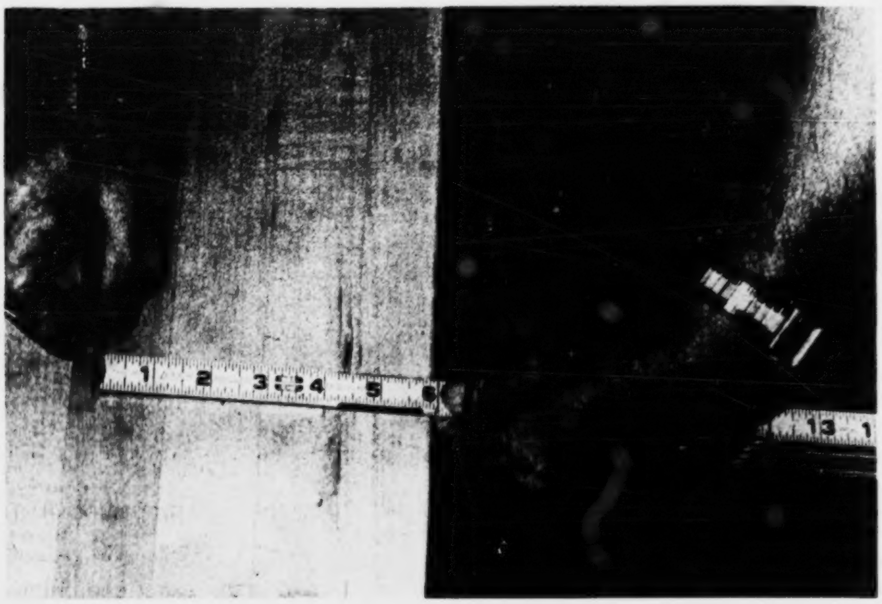


SCALE: 1/2" = 1'-0"

JOB SHEET #2

b. Layout tie location by scribing a line horizontally across form so ties will line up with the slots in the walers (Figure 28)

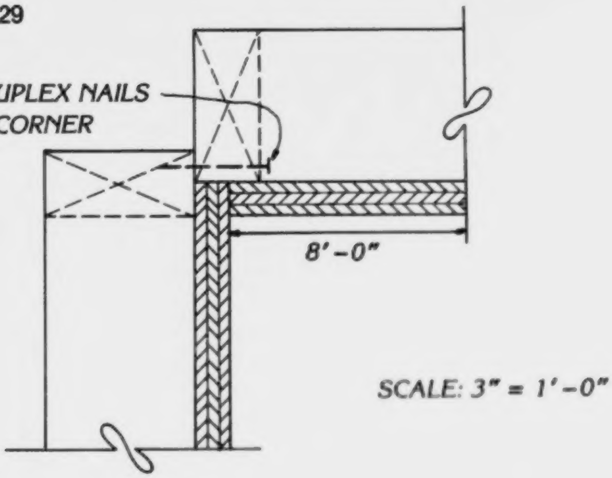
FIGURE 28



5. Set panels in excavation at proper location

6. Nail panel together at the corners (Figure 29)

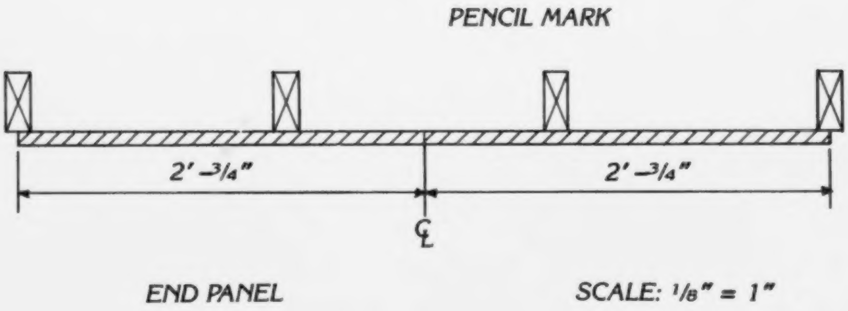
FIGURE 29


4 - 16d DUPLEX NAILS
EACH CORNER
8'-0"
SCALE: 3" = 1'-0"

JOB SHEET #2

7. Locate center of the four sides and square a mark across top edge of sheathing (Figure 30)

FIGURE 30


PENCIL MARK
2'-3/4"
2'-3/4"
℄
END PANEL
SCALE: 1/8" = 1"

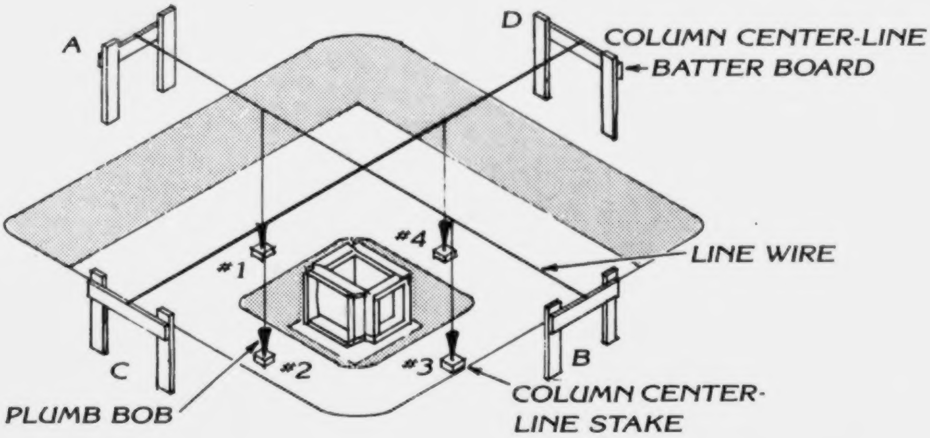
8. Set column center line stakes (See Figures 31)

   a. Attach string line to the previously set batter boards A-B and C-D

   b. Use plumb bob on lines to drive stakes in proper location and to locate exact center lines on stakes

   c. Drive a nail in top of each stake at the exact centerline location

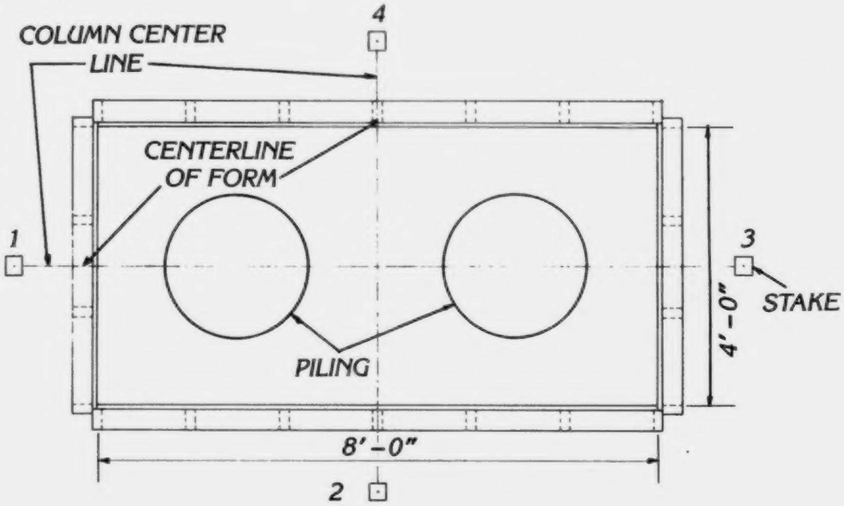
FIGURE 31


A
D
COLUMN CENTER-LINE
BATTER BOARD
#4
#1
LINE WIRE
C
#2
#3
B
PLUMB BOB
COLUMN CENTER-LINE STAKE

JOB SHEET #2

9. Secure string line to nails on top of centerline stakes and pull line taut (Figure 32)

FIGURE 32

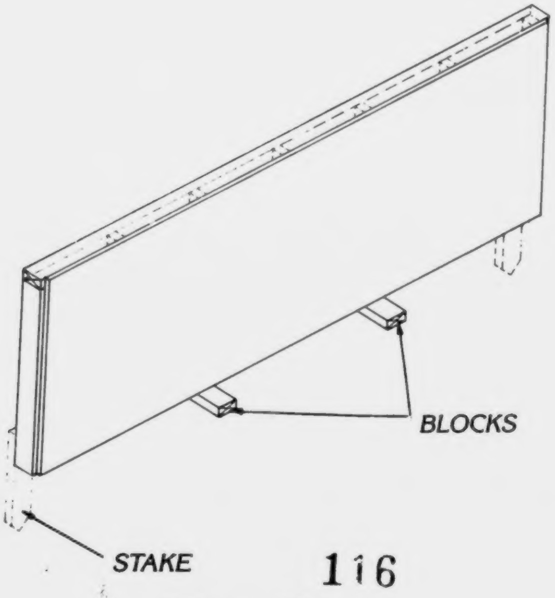

4
COLUMN CENTER LINE
CENTERLINE OF FORM
1
3
STAKE
4'-0"
PILING
8'-0"
2

10. Line up form centerline marks with the column centerlines (Figure 32)

11. Drive stakes at corners of form to hold it in position

12. Raise form to grade by blocking it up and nailing to stakes (Figure 33)

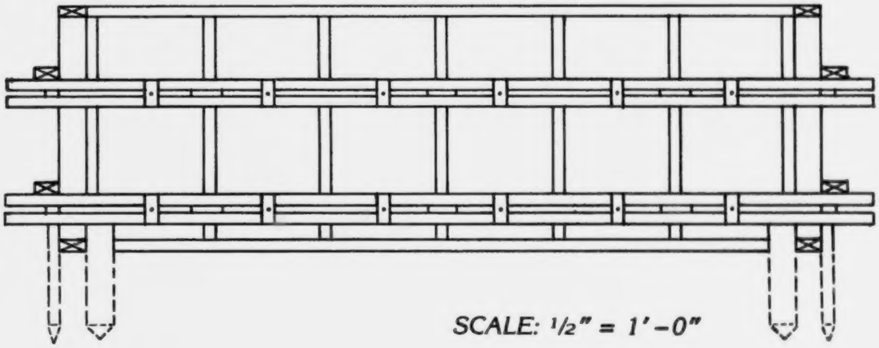
FIGURE 33


BLOCKS
STAKE

JOB SHEET #2

13. Install form ties through one side form and.one end form
14. Install walers on these two sides
15. Install tie clamps on ties on these two sides (Figure 34)

FIGURE 34



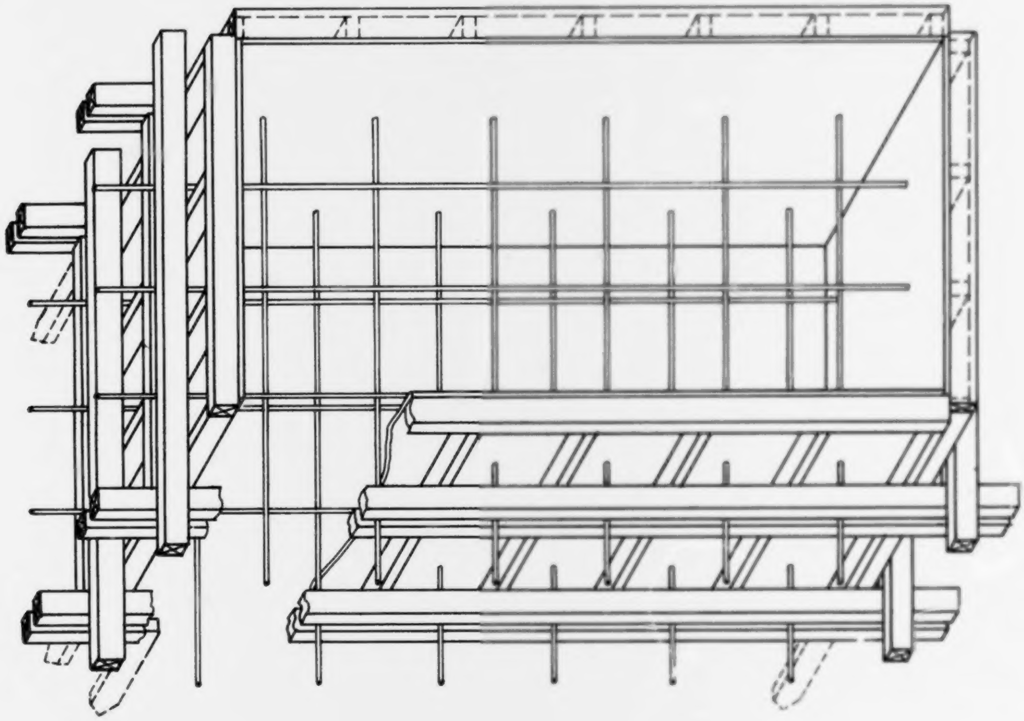
(NOTE: Form oil must be applied before reinforcing steel is installed.)

16. Cut spreaders to width of form
17. Feed ends of tie rods through holes in opposite forms
18. Install spreaders at top and bottom of form under centerline marks

JOB SHEET #2

19. Pull form tightly against spreaders and secure tie clamps (Figure 35)

FIGURE 35



20. Install strongbacks and bracing

    (NOTE: Be sure all bracing is nailed securely so that it will not vibrate loose.)

FOOTING FORMS
UNIT III

JOB SHEET #3 — CONSTRUCT AND SET FORMS FOR A PIER FOOTING

I. Tools and materials

(NOTE: Instructor will furnish drawings or dimensions.)

A. Power handsaw and extension cord

B. Handsaw

C. Claw hammer

D. Sledgehammer

E. One-hundred-foot steel tape

F. Folding rule or steel tape

G. Hand level

H. Builder's level

I. Electric drill motor and drills

J. Chalk line

K. Adjustable wrench, 10-inch

L. Line or wire

M. Plumb bob

N. Framing square

O. Large brush, spray can, roller, or mop for applying form oil

P. Stakes

Q. ¾" plywood sheathing

R. Column clamps

S. Spreaders

T. Form ties

JOB SHEET #3

U. 2×4s or 2×6s for braces, studs, and hanger

V. 1×4s for cleats

W. Nails

  1. 8d and 16d duplex

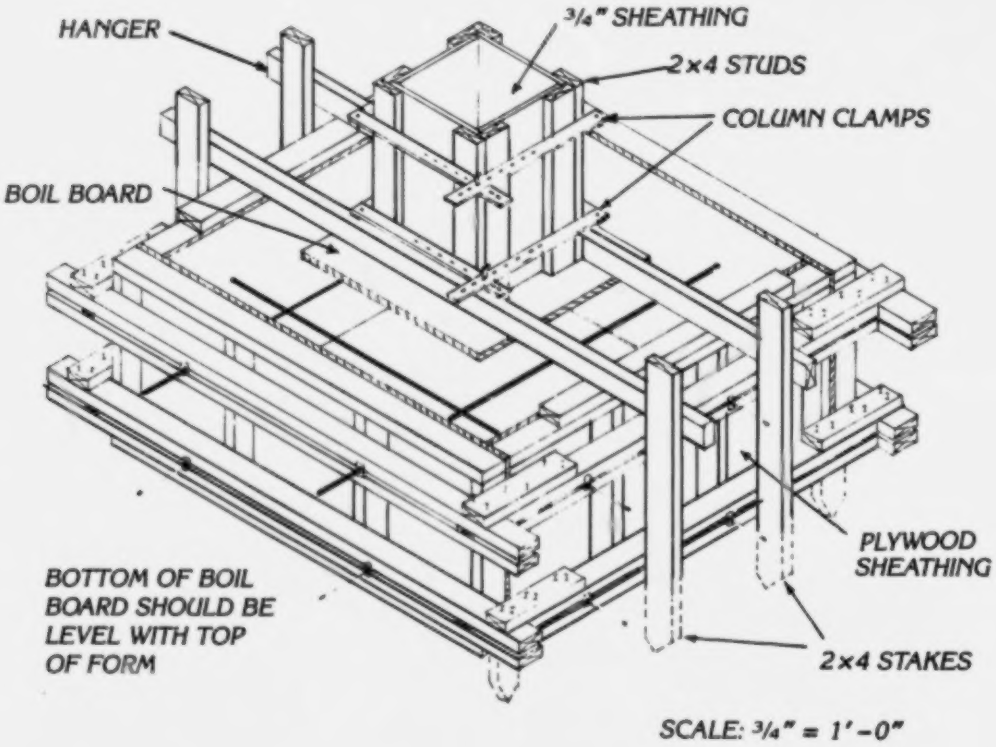
  2. 6d, 8d, and 16d common

X. Form oil

II. Procedure

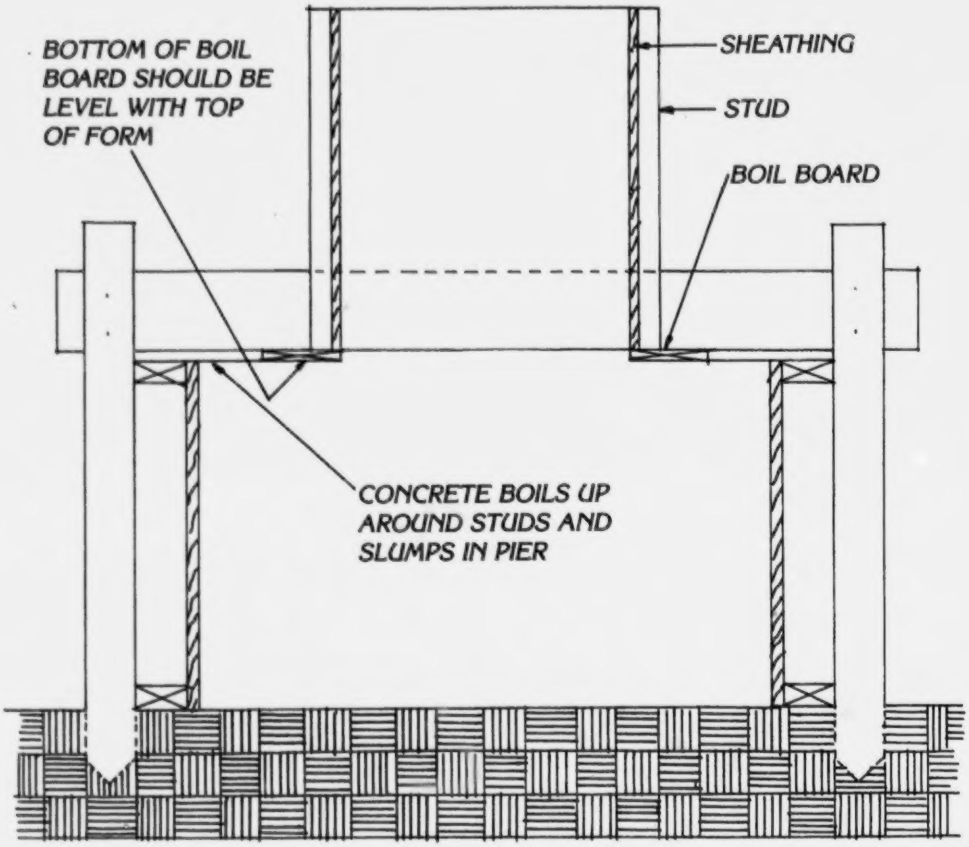
A. Consult with your instructor to determine size of the form (Figures 36 and 37)

FIGURE 36


HANGER
3/4" SHEATHING
2×4 STUDS
COLUMN CLAMPS
BOIL BOARD
PLYWOOD SHEATHING
BOTTOM OF BOIL BOARD SHOULD BE LEVEL WITH TOP OF FORM
2×4 STAKES
SCALE: 3/4" = 1'-0"

JOB SHEET #3

FIGURE 37


BOTTOM OF BOIL BOARD SHOULD BE LEVEL WITH TOP OF FORM
SHEATHING
STUD
BOIL BOARD
CONCRETE BOILS UP AROUND STUDS AND SLUMPS IN PIER

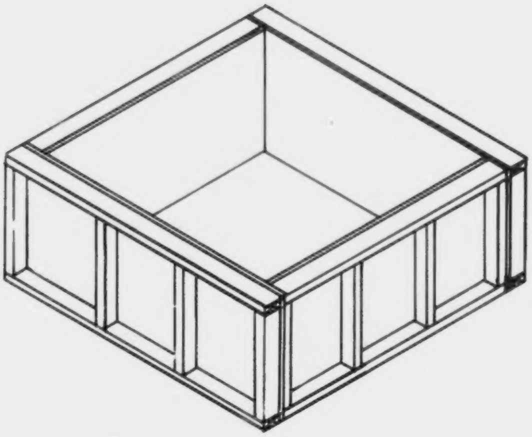
B. Build forms

1. Make a material cut list (Figure 36)
2. Cut material to size using material cut list

JOB SHEET #3

3. Build bottom form (Figure 38)

FIGURE 38



4. Build pier form panels (Figures 39 and 40)

FIGURE 39

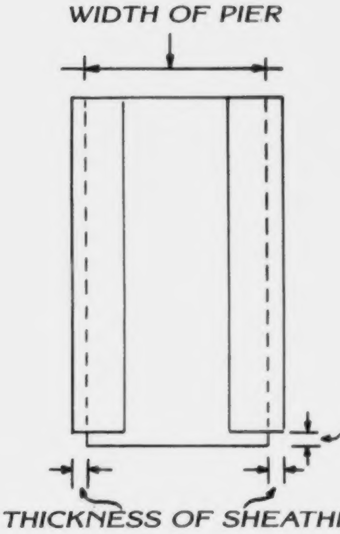
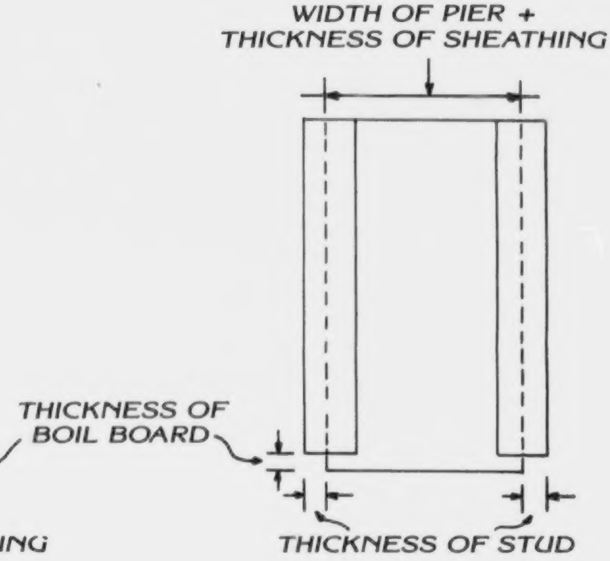

WIDTH OF PIER
THICKNESS OF SHEATHING

FIGURE 40


WIDTH OF PIER + THICKNESS OF SHEATHING
THICKNESS OF BOIL BOARD
THICKNESS OF STUD

JOB SHEET #3

5. Nail panels together (Figures 41 and 42)

FIGURE 41

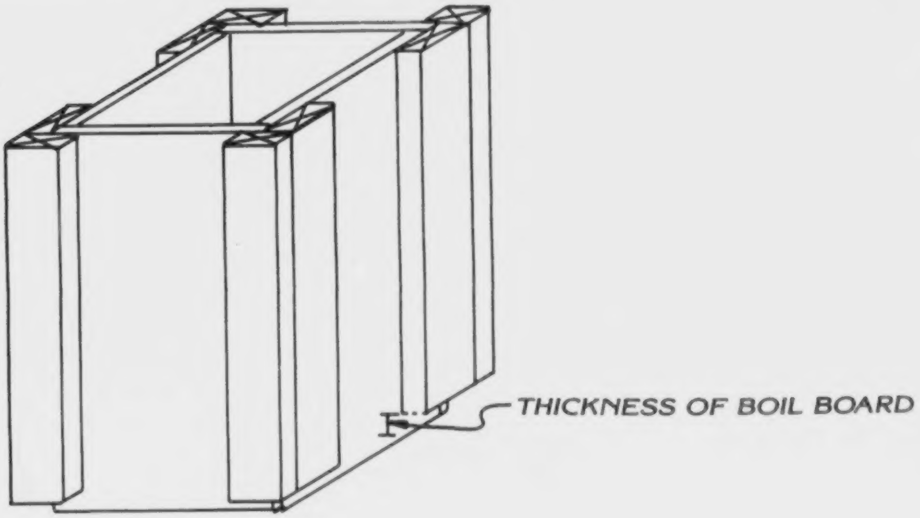
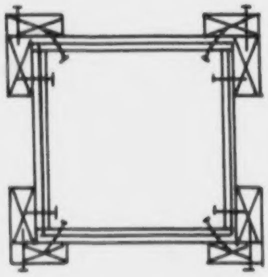

THICKNESS OF BOIL BOARD

FIGURE 42

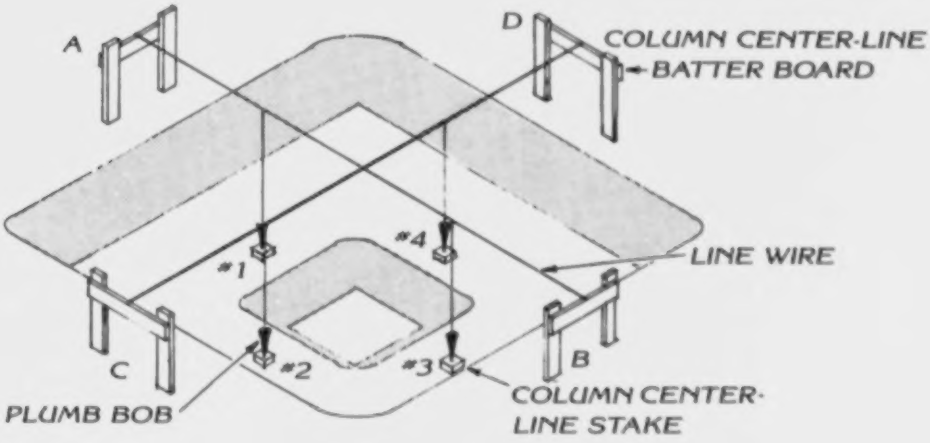


(NOTE: Be sure both forms are coated with form oil.)

JOB SHEET #3

C. Locate and set column centerline stakes (Figure 43)

FIGURE 43

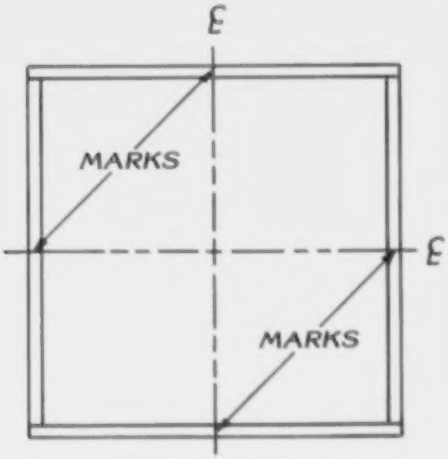

A
D
COLUMN CENTER-LINE
BATTER BOARD
#4
#1
LINE WIRE
C
#2
#3
B
PLUMB BOB
COLUMN CENTER-LINE STAKE

1. Stretch a line from points A-B and C-D
2. Use plumb bob to establish centerline stakes #1, #2, #3, and #4

D. Set the form

1. Set bottom form section in excavation
2. Mark centerline on all four sides of form (Figure 44)

FIGURE 44


℄
MARKS
℄
MARKS

JOB SHEET #3

3. Stretch lines between stakes A-B and C-D; pull taut (See Figure 45)

4. Locate form with center line marks directly under column centerlines, using plumb bob or hand level (Figures 45 and 46)

FIGURE 45

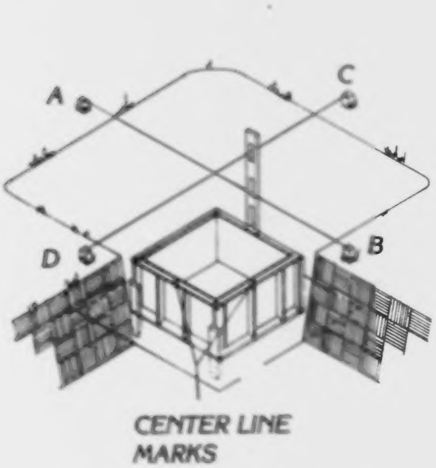
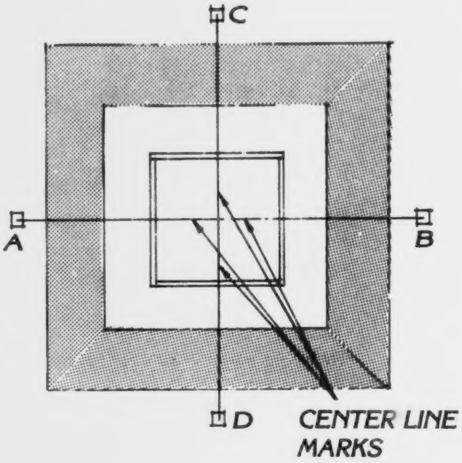

A
C
D
B
CENTER LINE MARKS

FIGURE 46

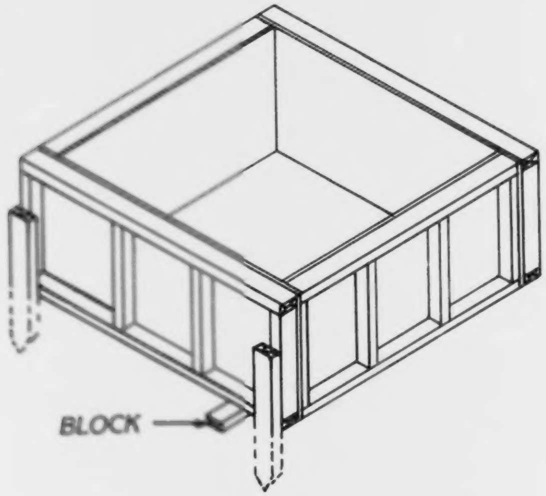

C
A
B
D
CENTER LINE MARKS

5. Drive stakes at four corners of form

6. Use builder's level and leveling rod to establish grade from bench mark to corners of form

7. Block form up to grade and nail to stakes (Figure 47)

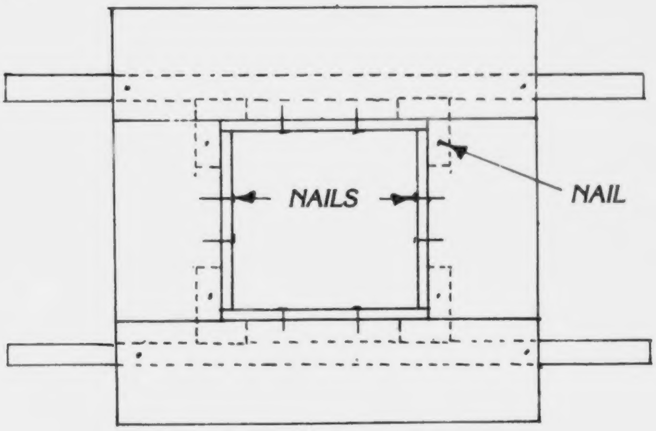
FIGURE 47



JOB SHEET #3

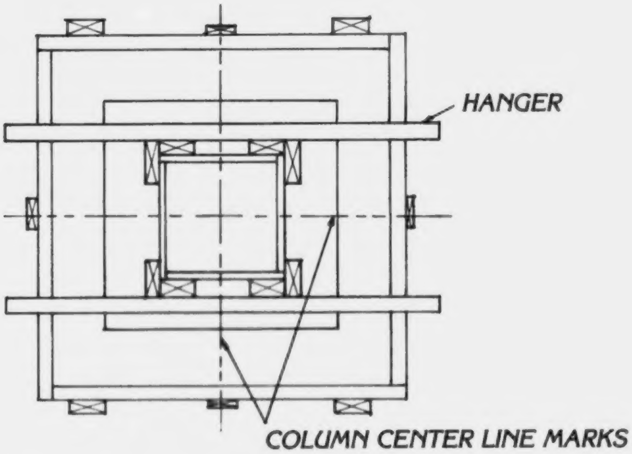
8. Turn pier panel upside down and install boil boards and hangers, installing hangers parallel to short boil boards (Figure 48)

FIGURE 48



9. Set pier form on bottom form and position it approximately on column center line marks (Figure 49)

FIGURE 49


HANGER
COLUMN CENTER LINE MARKS

   a. Raise hangers

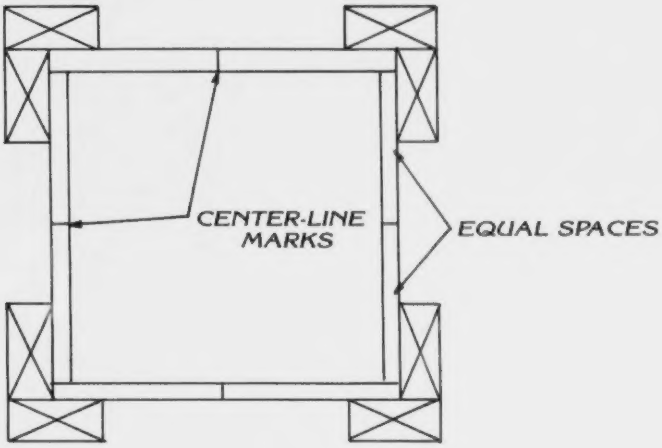
   b. Place a block between pier form and bottom form at the four points on which hangers sit

   c. Tack block in place

JOB SHEET #3

10. Mark centers of pier form sides on top of sheathing (Figure 50)

FIGURE 50



11. Plumb down from column centerline to marks on top of pier

12. Nail hangers to bottom form

13. Drive stakes along sides of form and hanger

14. Check alignment of pier; if pier is still aligned, nail stakes to hangers (See Figure 51)

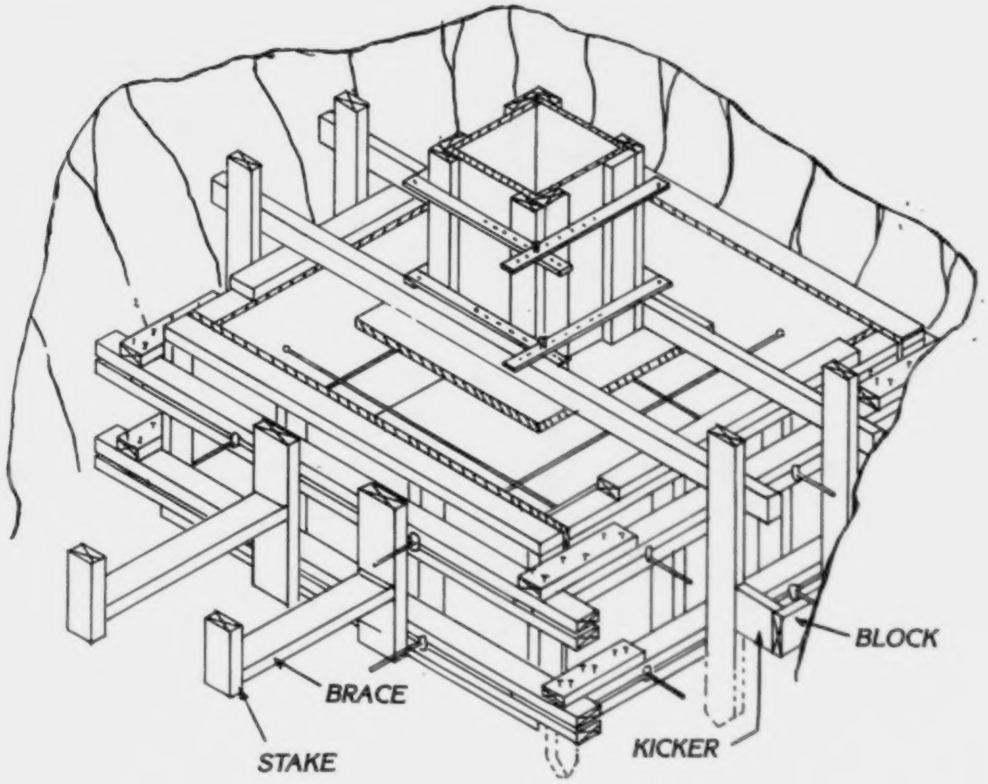
15. Install column clamps, positioning one on top of hanger and one 6 inches from top of pier form (See Figure 51)

    (NOTE: If piers are over 2 feet high, more clamps will be needed.)

JOB SHEET #3

16. Brace or use kicker on bottom form (Figure 51)

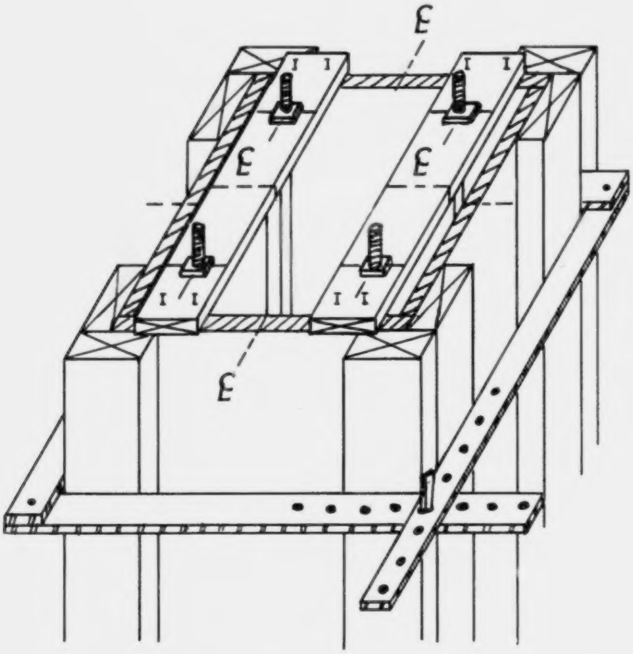
FIGURE 51


BLOCK
BRACE
STAKE
KICKER

JOB SHEET #3

E. Build and set bolt template (Figure 52)

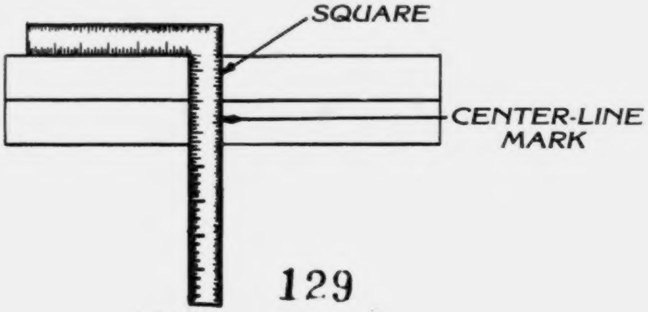
FIGURE 52



TEMPLATE *SCALE: 1/4" = 1'-0"*

1. Cut two pieces of 1×3 long enough to reach across top of pier form
2. Align the pieces as shown in Figure 53 and make a center line mark across them (Figure 53)

FIGURE 53

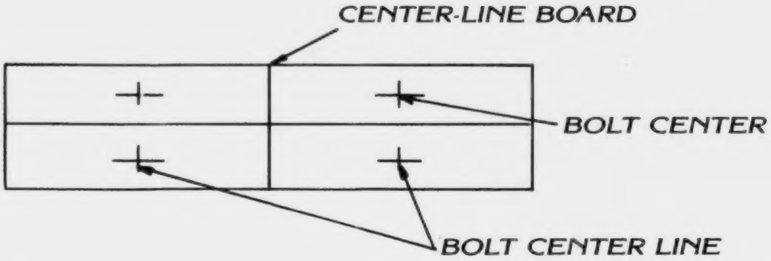


JOB SHEET #3

3. Lay out bolt spacing on the length of the two boards; cross these lines with a center line mark on the width (Figure 54)

   (NOTE: Accuracy is of the utmost importance in all bolt layout.)

FIGURE 54



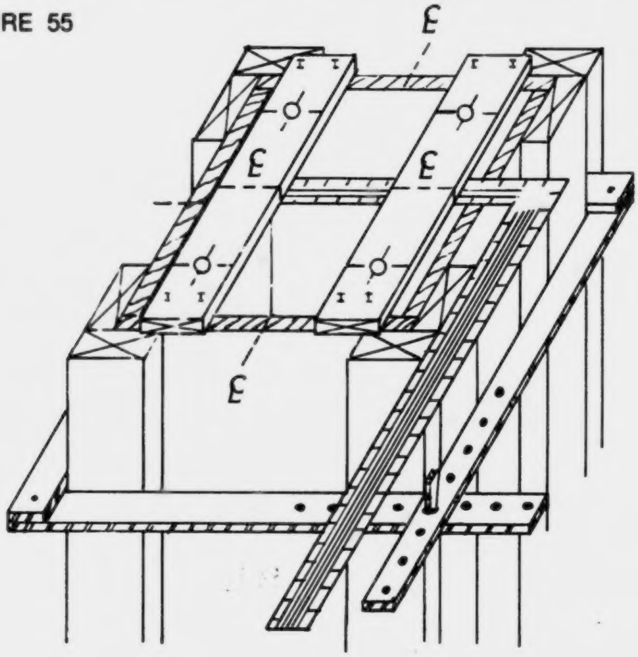
4. Drill holes not more than 1/16" larger than bolt at crosses marking bolt centers

5. Set boards on two sides of pier form, using a square to locate them on the column centerlines

6. Measure from centerlines of opposite forms to centerlines of bolt holes and nail securely to form (Figure 55)

   (NOTE: Recheck bolts for location and plumb after concrete is poured.)

FIGURE 55



FOOTING FORMS
UNIT III

JOB SHEET #4 — STRIP PIER FOOTING FORMS AND PREPARE FOR ERECTION AT ANOTHER LOCATION

I. Tools and materials

- A. Wrecking bar
- B. Claw hammer
- C. Large brush, spray can, roller, or mop for applying form oil
- D. Form oil

II. Procedure

- A. Strip forms

  (NOTE: Forms are stripped in the reverse order of setting.)

  1. Remove pier form, taking care not to damage the form parts any more than necessary so that they may be reused
     - a. Remove column clamps and hangers
     - b. Remove duplex nails from two corners of form
     - c. Pry this side from pier

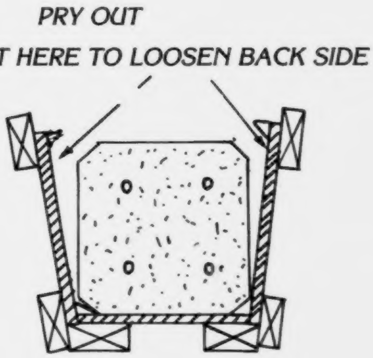
       CAUTION

       Do not pry against the green concrete.

     - d. Remove remaining three sides as one unit (Figure 56)

JOB SHEET #4

FIGURE 56



2. Remove all nails from braces, kickers, and cleats
3. Remove braces, kickers, and cleats
4. Remove duplex nails from one corner of bottom form if form is small
5. Spread form apart at this corner and remove as one unit

   (NOTE: If forms are large, each side will need to be removed individually.)

B. Prepare forms for erection at next location

1. Renail single pier panel to three panel sections, and replace boil board if it was damaged
2. Attach hangers
3. Renail corners of bottom form sections
4. Coat inside of forms with form oil
5. Transport forms to next location

C. Clean up work area and put away tools and materials

FOOTING FORMS
UNIT II

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated to footing forms with their correct definitions. Write the correct numbers in the blanks.

______a. Power tool used to consolidate concrete

______b. Reduction in bulk of fill

______c. Enlarged area at the base of a wall, pier, or column used to distribute the weight of the superstructure

______d. Consistency (wetness) of concrete

______e. Shallow saw-cut in which to fit line to hold it in place

______f. Cavity or depression made by removal of dirt by cutting, digging, or scooping

______g. Given grade

______h. Steel used in concrete to increase the tensile strength of the concrete

______i. Process used to finish the surface of concrete

______j. Admixture used in concrete to improve workability and resistance to freezing, thawing, and scaling

______k. Nail used in forming and designed for easy removal

______l. Part of a form to keep concrete from boiling up out of the form

1. Footing
2. Float or rod
3. Vibrator
4. Reinforcing
5. Excavation
6. Air-entraining admixture
7. Compaction
8. Boil board
9. Elevation
10. Slump
11. Kerf
12. Duplex nail (double-headed)

2. Select from the following list factors that control the size and shape of footings. Write an "X" in the blank before each correct answer.

______a. Specifications

______b. Soil conditions

______c. Type of material used

______d. Depth of footings

______e. Climate

TEST

_____f. Building codes

_____g. Type of concrete used

_____h. Size of the structure

3. Name four types of footings

a. ____________________

b. ____________________

c. ____________________

d. ____________________

4. Name two styles of footings

a. ____________________

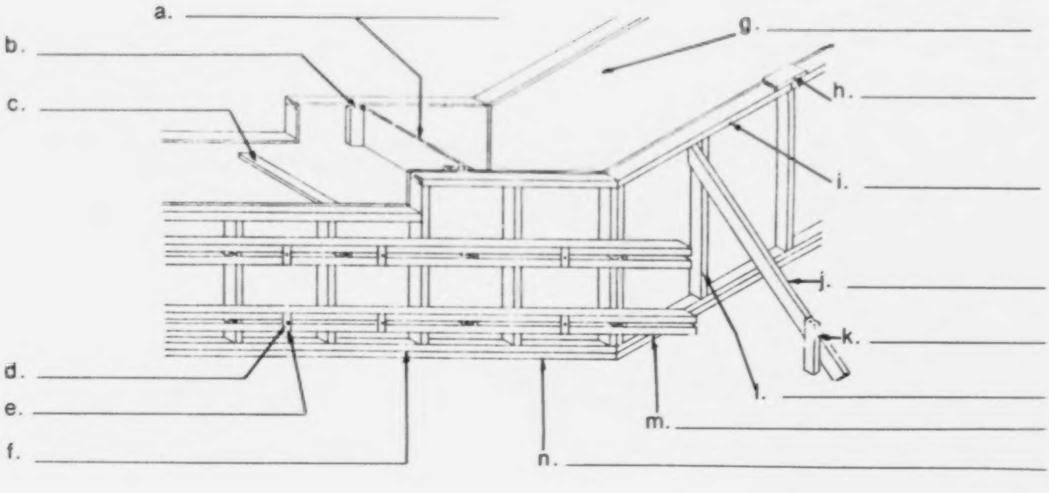
b. ____________________

5. Identify parts of the footing form illustrated. Write the correct names in the blanks.

Stud
Waler
Bottom plate
Sole plate
Scab

Stake
Form tie
Form tie clamp
Top plate
Bulkhead

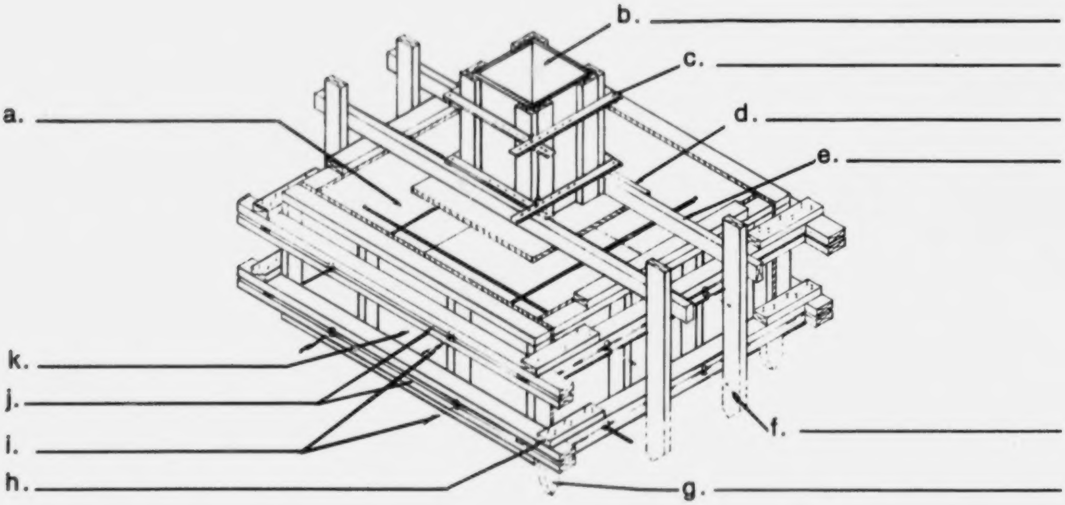
Sheathing
Spreader
Cleat
Brace



TEST

6. Identify parts of the pier footing form illustrated. Write the correct names in the blanks.

Footing assembly
Pier assembly
Form stake
Plywood sheathing
Hanger stake
Cleat
Form Ties
Hanger
Waler
Boil board
Column clamps



(NOTE: Test question 7 lists the job sheets. It is an import part of this test. If it has not been completed, check with your instructor.)

7. Demonstrate ability to

   a. Construct and set forms for a continuous footing.

   b. Construct and set forms for a pile cap 4′ −0″ × 8′-0″.

   c. Construct and set forms for a pier footing.

   d. Strip pier footing forms and prepare for erection at another location.

FOOTING FORMS
UNIT II

ANSWERS TO TEST

1. a. 3
   b. 7
   c. 1
   d. 10
   e. 11
   f. 5
   g. 9
   h. 4
   i. 2
   j. 6
   k. 12
   l. 8

2. b, c, e, f, h

3. Any four of the following is correct

   a. Continuous
   b. Stepped
   c. Pier
   d. Grade beam
   e. Spread
   f. Pile cap
   g. Grillage
   h. Mass concrete footing

4. Any two of the following is complete

   a. Square
   b. "T"
   c. Pier
   d. Pier and beam

5. a. Bulkhead
   b. Cleat
   c. Spreader
   d. Form tie
   e. Form tie clamp
   f. Bottom plate
   g. Sheathing
   h. Scab
   i. Top plate
   j. Brace
   k. Stake
   l. Stud
   m. Waler
   n. Sole plate

6. a. Footing assembly
   b. Pier assembly
   c. Column clamp
   d. Boil board
   e. Hanger
   f. Hanger stake
   g. Form stake
   h. Cleat
   i. Form ties
   j. Walers
   k. Plywood sheating

7. Performance skills evaluated to the satisfaction of the instructor

EDGE FORMS ON GRADE
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able to identify and construct various types of edge forms and should be able to set screeds. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with edge forms on grade.
2. Identify parts of an edge form.
3. Name types of pours using edge forms.
4. Name types of materials used to construct edge forms.
5. Distinguish between screeds and bulkheads.
6. Identify different types of screeds.
7. Demonstrate ability to
    a. Construct edge forms for a slab on grade without foundation.
    b. Construct edge forms for a slab on grade with foundation.
    c. Construct edge forms for a patio.
    d. Construct edge forms for a sidewalk.
    e. Set screeds for a floor slab.

EDGE FORMS ON GRADE
UNIT III

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Transparency masters

      1. TM #1 — Edge Form Without Wall

      2. TM #2 — Edge Form with Wall

      3. TM #3 — Types of Pours Using Edge Forms

   D. Information sheet

   E. Job sheets

      1. Job Sheet #1 — Construct Edge Forms for a Slab on Grade Without Foundation

      2. Job Sheet #2 — Construct Edge Forms for a Slab on Grade with Foundation

      3. Job Sheet #3 — Construct Edge Forms for a Patio

      4. Job Sheet #4 — Construct Edge Forms for a Sidewalk

      5. Job Sheet #5 — Set Screeds for a Floor Slab

   F. Test

   G. Answers to test

II. Instructor's guide

   A. Review unit and plan presentation.

   B. Obtain materials to supplement unit.

      1. Equipment and materials for procedures outlined in the job sheets

      2. Copies of supplement as appropriate

      3. Transparencies and competency profiles

SUGGESTED ACTIVITIES

(NOTE: The transparencies and competency profiles for this manual are available from the Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

4. Resource materials

   a. Latest edition of *Modern Carpentry* by Willis H. Wagner

      (NOTE: Order from The Goodheart-Willcox Co., 123 West Taft Drive, South Holland, Illinois 60473.)

   b. *Cement Masonry* by Laborn J. "Bud" Hendrix

      (NOTE: Order from the State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074. Out-of-State instructors may order from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

5. Examples of various types of edge forms and screeds

C. Introduce unit.

SUGGESTIONS:

- Stress the importance of good, solid forms.
- Show examples of different types of edge forms and screeds.
- Explain the difference and why any particular one is used instead of another.
- Explain the different methods, techniques and materials used by different contractors.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

1. Use Information Sheet, Section I to introduce terms and definitions associated with edge forms on grade.

   SUGGESTIONS:

   - Show students examples of appropriate terms.

SUGGESTED ACTIVITIES

- Explain how learning these terms and definitions will help the students to better understand the information in this unit.

2. Use Information Sheet, Section II to discuss parts of an edge form.

   SUGGESTION:

   - Use Transparencies #1 and #2 to illustrate and reinforce your discussion.

3. Use Information Sheet, Section III to discuss types of concrete pours using edge forms.

   SUGGESTIONS:

   - Take students on a field trip and show them examples of types of concrete pours using edge forms.
   - Have students point out different examples.
   - Use Transparency #3 to reinforce your discussion.

4. Use Information Sheet, Section IV to discuss types of materials used to construct edge forms.

   SUGGESTIONS:

   - Show students examples of different types of materials.
   - Show how materials may be used together to construct combination forms.

5. Use Information Sheet, Section V to discuss the differences between screeds and bulkheads.

   SUGGESTIONS:

   - Show students examples of different types of screeds and stakes.
   - Show students examples of different types of bulkheads; explain where they are used.
   - Explain how and where screeds are used.
   - Show students different methods used for screeds and different methods used to set screeds.
   - Have students identify parts of an edge form.

SUGGESTED ACTIVITIES

- Have students demonstrate their ability to put parts of a form together before actual construction in the field.
- Have each student demonstrate the ability to drive a stake straight and flush with a line and flush with the top of a form.
- Have each student demonstrate the ability to set stakes to grade for a screed.
- Have each student demonstrate the ability to set a bulkhead.
- Demonstrate and discuss procedures outlined in Job Sheets #1 through #5.
- Have students complete the job sheets.

H. Give test

I. Critique test and discuss in class.

J. Complete appropriate section of competency profiles.

III. Unit references

A. Burke, Arthur E., Ralph J. Danzell, and Gilbert Townsend. *Architectural and Building Trades Dictionary.* 2nd ed. Chicago, Illinois: American Technical Society, 1955.

B. *Concrete Form Construction.* Albany, New York: Delmar Publications.

C. Hendrix, Laborn J. "Bud", and Bob Patton. *Cement Mason's* Curriculum. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1975.

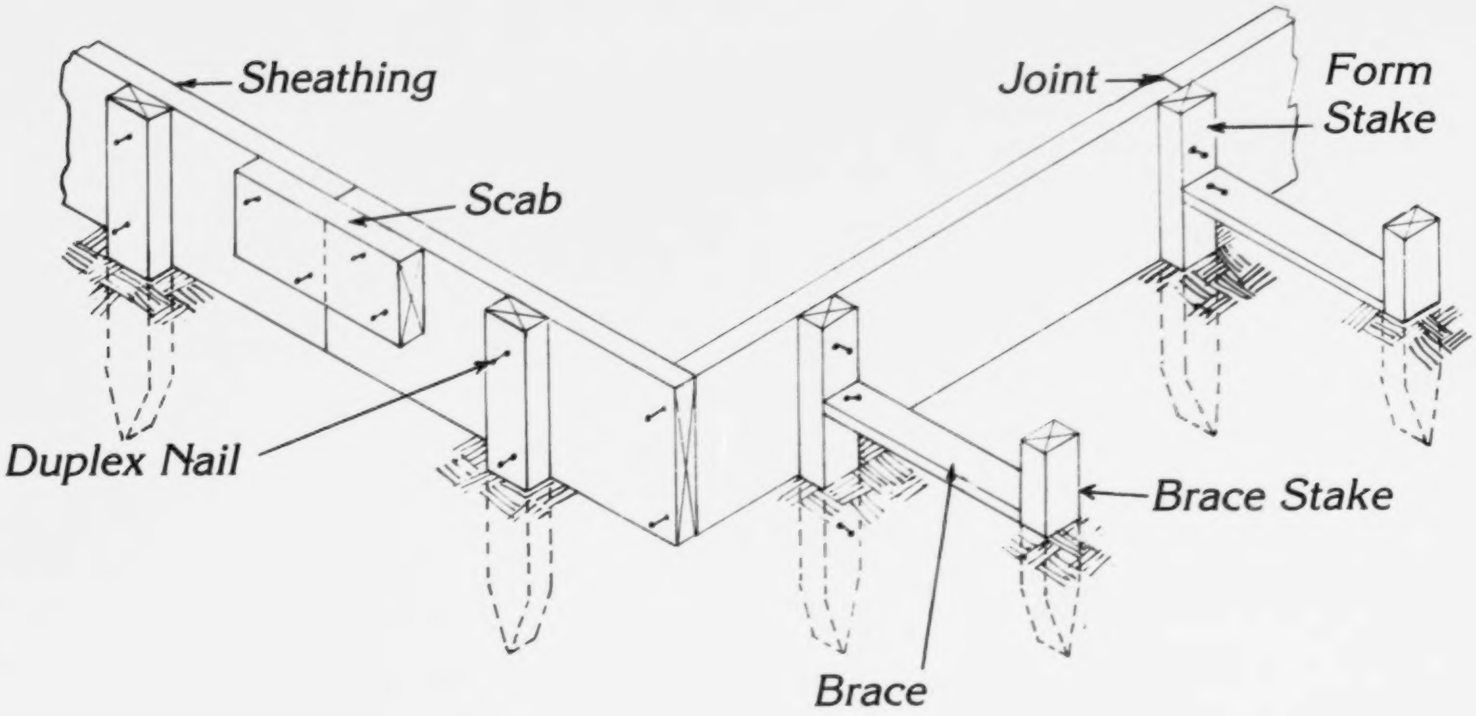
D. Hendrix, Laborn J. "Bud", *Commercial Carpentry*, Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1979.

C. Hendrix, Laborn J. "Bud", and Bob Patton. *Construction Craftsman's* Curriculum. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1978.

F. Peurifoy, R. L. *Formwork for Concrete Structures.* New York: McGraw-Hill Book Company, 1964.

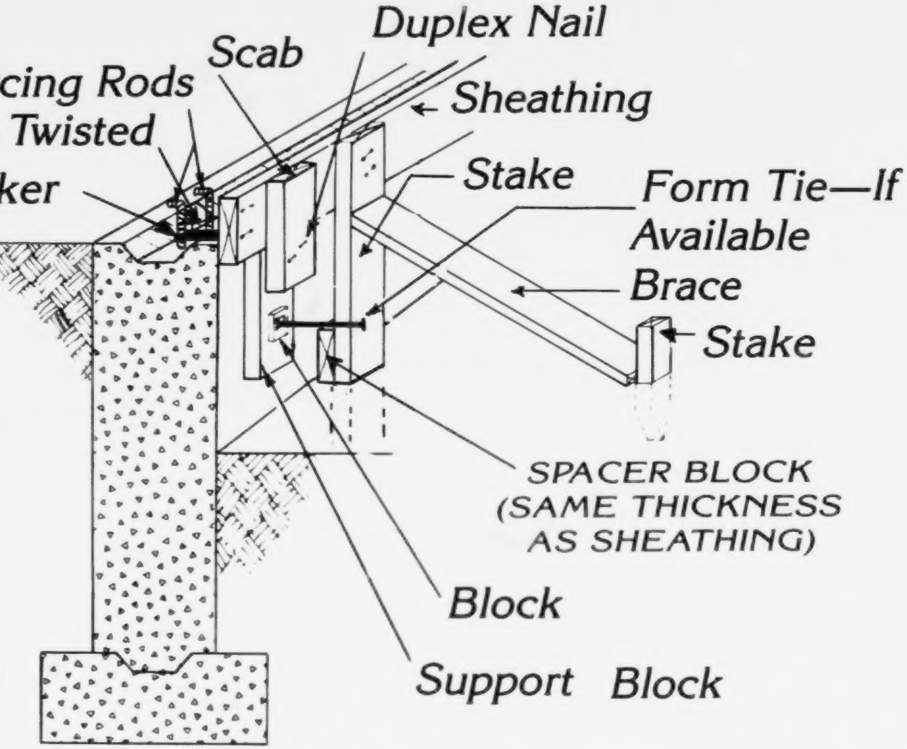
G. Smith, Ronald C. *Principles and Practices of Heavy Construction.* Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1967.

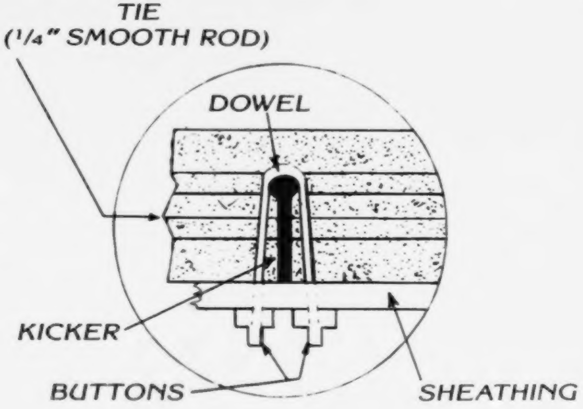
Edge Form Without Wall



Sheathing
Joint
Form
Stake
Scab
Duplex Nail
Brace Stake
Brace

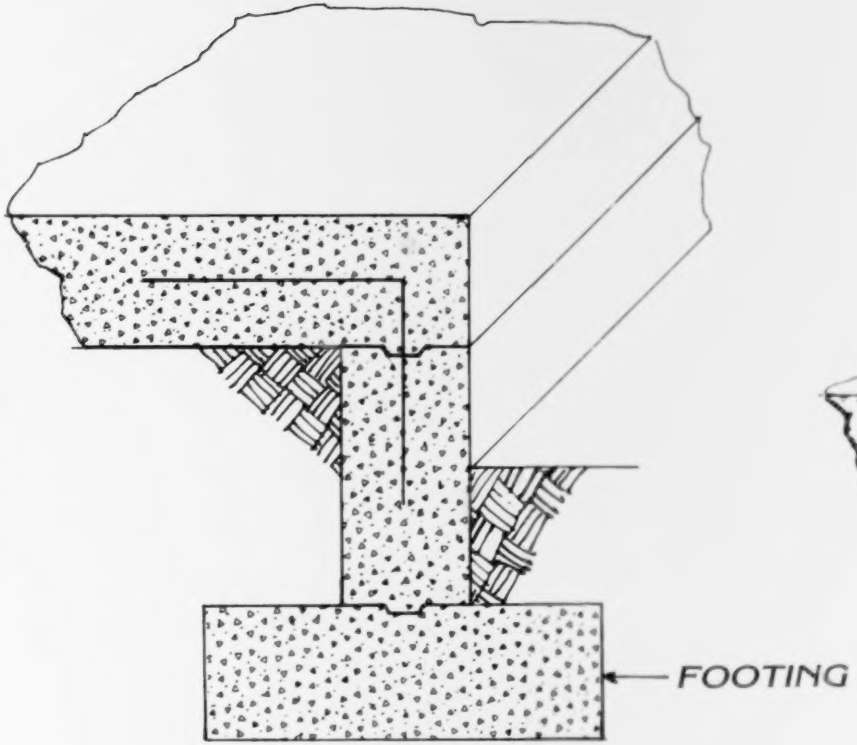
Edge Form with Wall


Duplex Nail
Scab
Reinforcing Rods
#9 Tie Wire Twisted
Sheathing
Kicker
Stake
Form Tie—If Available
Brace
Stake
SPACER BLOCK (SAME THICKNESS AS SHEATHING)
Block
Support Block

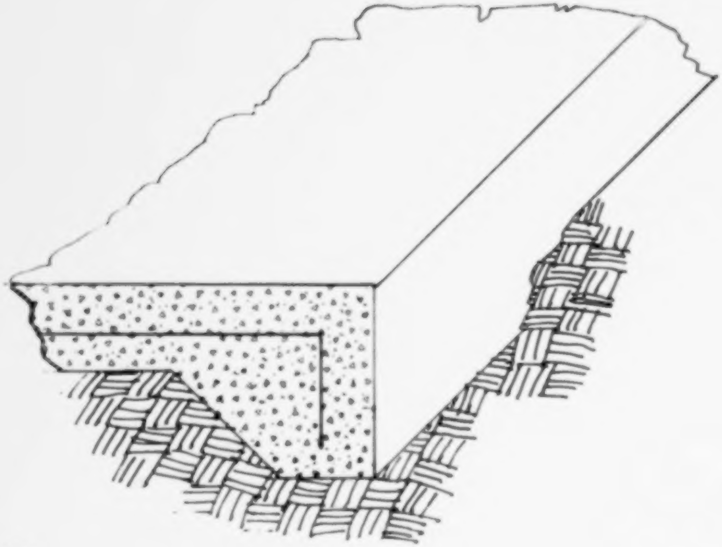

TIE (1/4" SMOOTH ROD)
DOWEL
KICKER
BUTTONS
SHEATHING

ALTERNATE METHOD OF TYING FORM TO WALL

Types of Pours Using Edge Forms



Floor With Foundation



Floor Without Foundation

EDGE FORMS ON GRADE
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Edge form — Low form placed at perimeter of slab

B. Brace — Piece of wood or other material that directs, resists, or supports weight or pressure

C. Duplex nail — Double-headed nail used in forming and designed for easy removal

D. Foundation — That portion of a wall, including the footing, upon which building rests

E. Grade point — Level of finished concrete in a form

F. Monolithic pour — Continuous mass of concrete cast as a single unit

G. Sheathing — Wood or metal that makes up the face of a form

H. Stakes — Small boards or steel bars sharpened on one end and driven into ground to help support a form

I. Expansion joint — Preformed piece of fibrous or asphaltic material used to separate units of concrete to prevent cracking due to expansion

J. Slab — Section of concrete larger in its horizontal dimensions than in thickness

K. Screed — Temporary guide used for rodding concrete to a finish grade

L. Scab — Piece of material nailed across a splice to strengthen and hold it together

M. Dowel — Short piece of steel bar inserted through a bulkhead to tie adjoining pours together

N. Plumb bob — Tool or device attached to a string; used to set and/or check the plumb or perpendicular of a surface

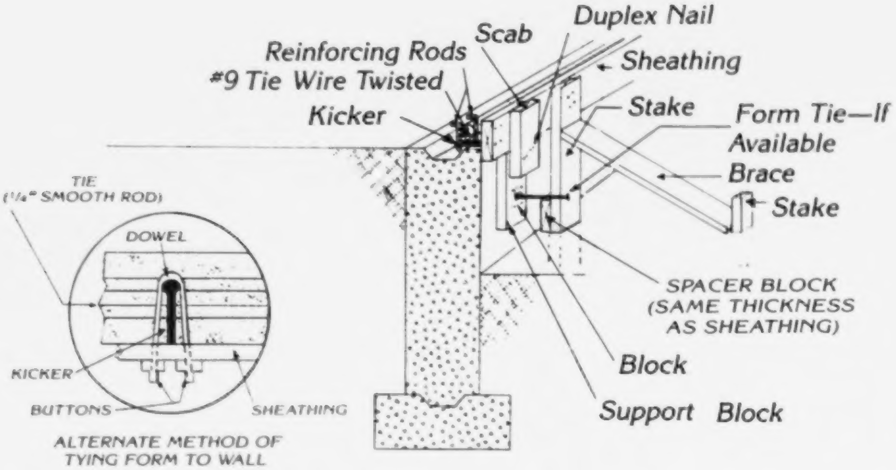
O. Form tie — Wire or metal cross tie used to hold the pressure of wet concrete and maintain proper wall thickness

INFORMATION SHEET

II. Parts of an edge form (Figures 1 and 2)

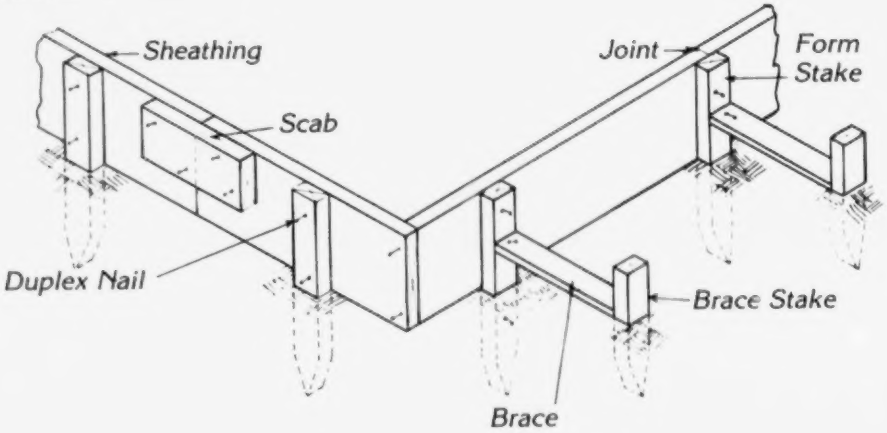
A. Edge form with wall

FIGURE 1


Duplex Nail
Scab
Reinforcing Rods
Sheathing
#9 Tie Wire Twisted
Stake
Form Tie—If Available
Kicker
Brace
Stake
TIE (1/4" SMOOTH ROD)
DOWEL
SPACER BLOCK (SAME THICKNESS AS SHEATHING)
Block
KICKER
BUTTONS
SHEATHING
Support Block
ALTERNATE METHOD OF TYING FORM TO WALL

B. Edge form without wall

FIGURE 2


Sheathing
Joint
Form Stake
Scab
Duplex Nail
Brace Stake
Brace

INFORMATION SHEET

III. Types of pours using edge forms

  A. Floor with foundation

  B. Floor without foundation

  C. Parking lots and air strips

  D. Driveways and streets

  E. Sidewalks

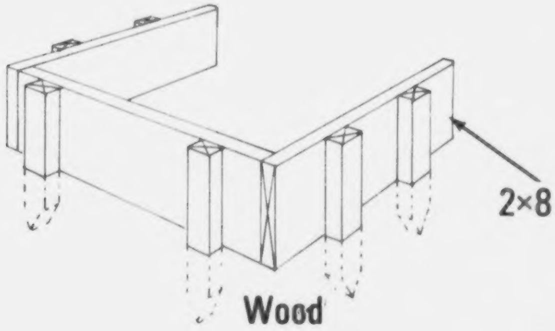
  F. Approaches

IV. Types of materials used to construct edge forms (Figures 3-6)

  A. Wood

  EXAMPLE:

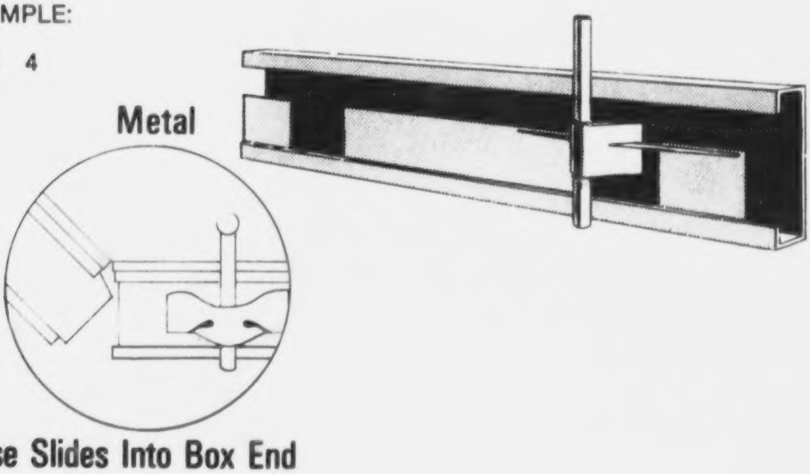
FIGURE 3



  B. Metal

  EXAMPLE:

FIGURE 4


Metal
Nose Slides Into Box End

INFORMATION SHEET

C. Combination wood and metal

EXAMPLES:

FIGURE 5

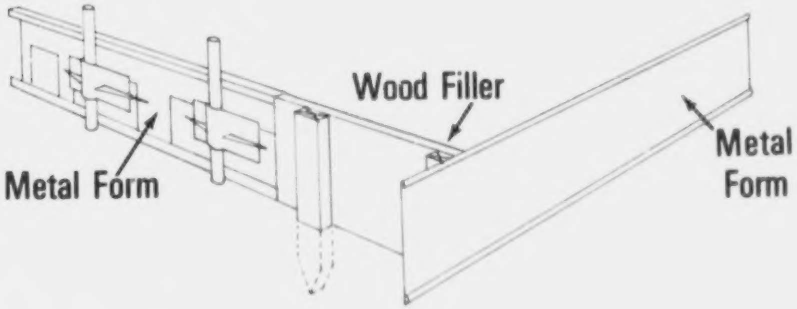
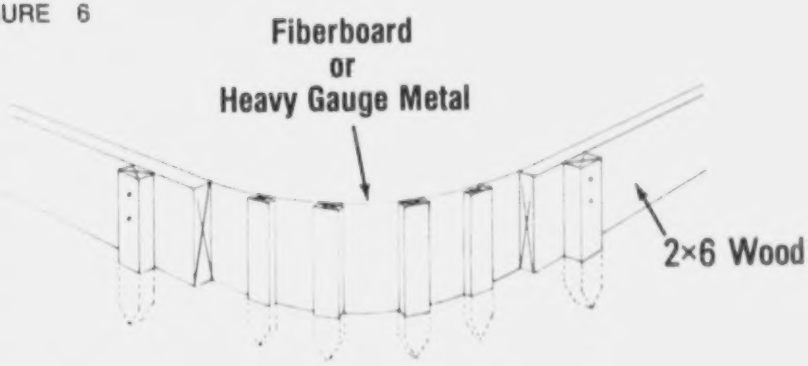

Wood Filler
Metal Form
Metal Form

FIGURE 6


Fiberboard or Heavy Gauge Metal
2×6 Wood

V. Screeds and bulkheads (Figures 7 and 8)

A. Screed

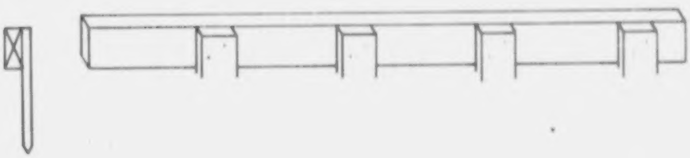
1. Temporary guide set to grade and used for rodding (dragging off) concrete to finish grade

2. Removed after concrete is placed

3. Usually set no more than 12 feet apart

EXAMPLE:

FIGURE 7



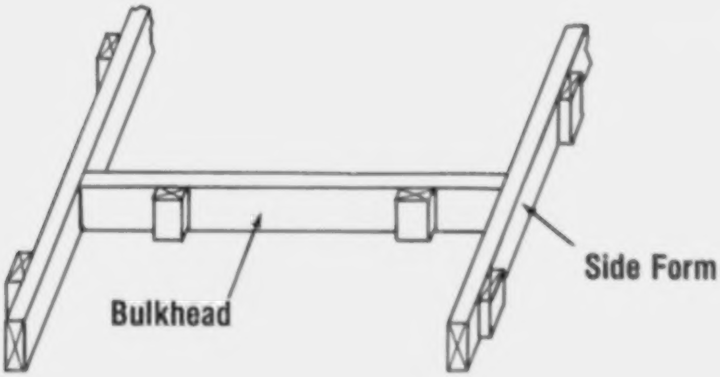
INFORMATION SHEET

B. Bulkhead

1. Form used to contain concrete and to cut off concrete pour
2. Can be used as a guide for rodding (dragging off) concrete to finish grade
3. Removed after concrete has set

EXAMPLE:

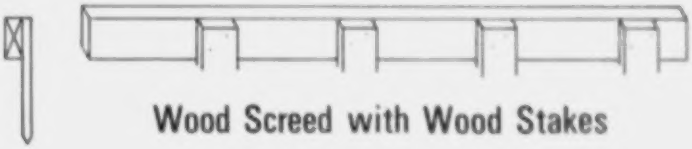
FIGURE 8


Side Form
Bulkhead

VI. Types of screeds (Figures 9-14)

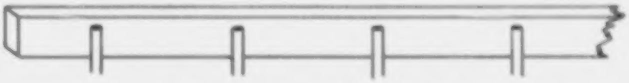
A. Wood screeds with wood stakes

FIGURE 9


Wood Screed with Wood Stakes

B. Wood screeds with metal stakes

FIGURE 10

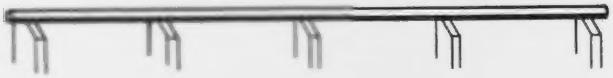


Wood Screed with Metal Stakes

INFORMATION SHEET

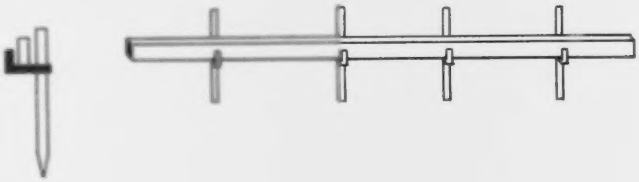
C. Pipe screed with wood stakes

FIGURE 11



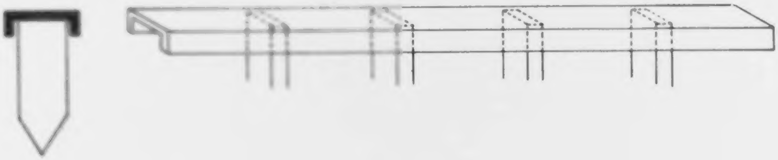
D. Steel bar with metal stake and bracket

FIGURE 12



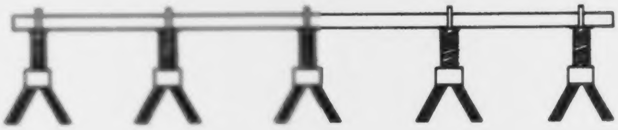
E. Steel channel with wood stakes

FIGURE 13



F. Pipe screed with adjustable screed chairs

FIGURE 14



(NOTE: Outside forms and bulkheads are often used for screeds.)

EDGE FORMS ON GRADE
UNIT III

JOB SHEET #1 — CONSTRUCT EDGE FORMS FOR A SLAB ON GRADE WITHOUT FOUNDATION

I. Tools and materials

  A. Sledge hammer

  B. Claw hammer

  C. Power handsaw and extension cord

  D. Handsaw

  E. One-hundred-foot tape

  F. Folding rule or steel tape

  G. Hand level

  H. Chalkline

  I. Builder's level and rod

  J. Plumb bob

  K. Stakes

  L. 2×10's for sheathing

  M. 8d and 16d duplex nails

II. Procedure

  A. Perform site layout

  (NOTE: Review *Fundamentals of Carpentry*, "Site Layout" if necessary.)

  B. Offset lines on batterboards the thickness of the forms ($1\frac{1}{2}$ inches)

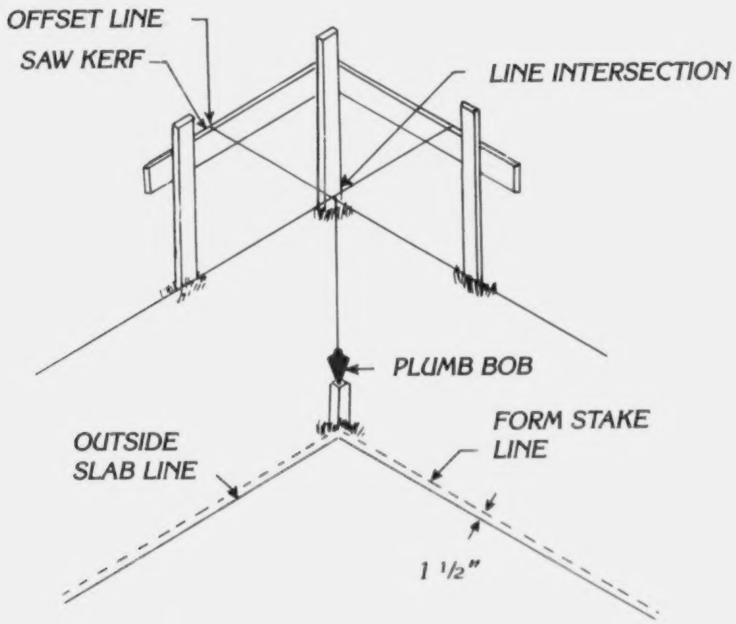
  C. Secure line to batterboards where new lines were established

  D. Attach plumb bob to line intersections

JOB SHEET #1

E. Drive corner form stake and set a nail exactly at point of plumb bob (Figure 15)

FIGURE 15


OFFSET LINE
SAW KERF
LINE INTERSECTION
PLUMB BOB
OUTSIDE SLAB LINE
FORM STAKE LINE
1 1/2"

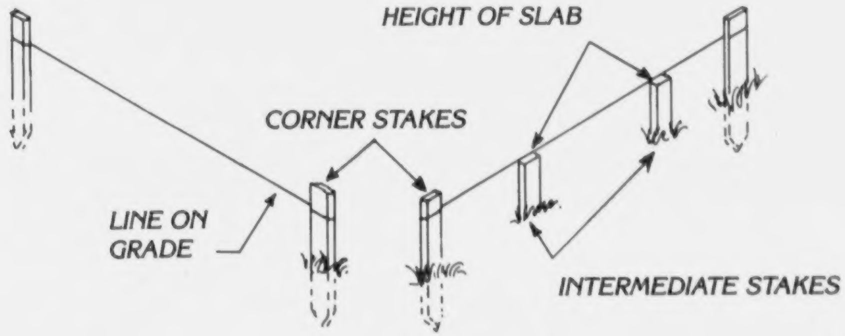
F. Repeat steps D and E on the other three corners

G. Establish grade on all corner stakes

H. Secure line to first corner stake on established grade and stretch line tight to established grade on the next corner stake (Figure 16)

(NOTE: Be sure that the line is tight and that there is no sag in the line.)

FIGURE 16

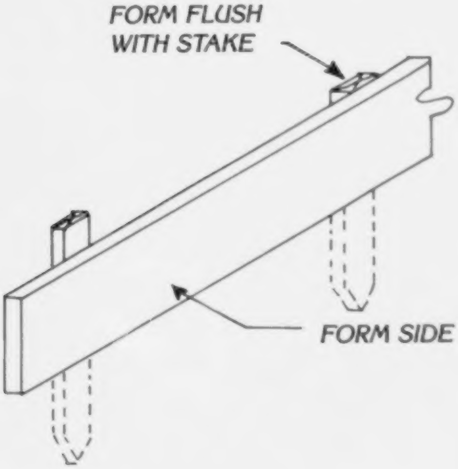

HEIGHT OF SLAB
CORNER STAKES
LINE ON GRADE
INTERMEDIATE STAKES

JOB SHEET #1

I. Drive all intermediate stakes straight down, with face of stake plumb with line and top of stake flush with line

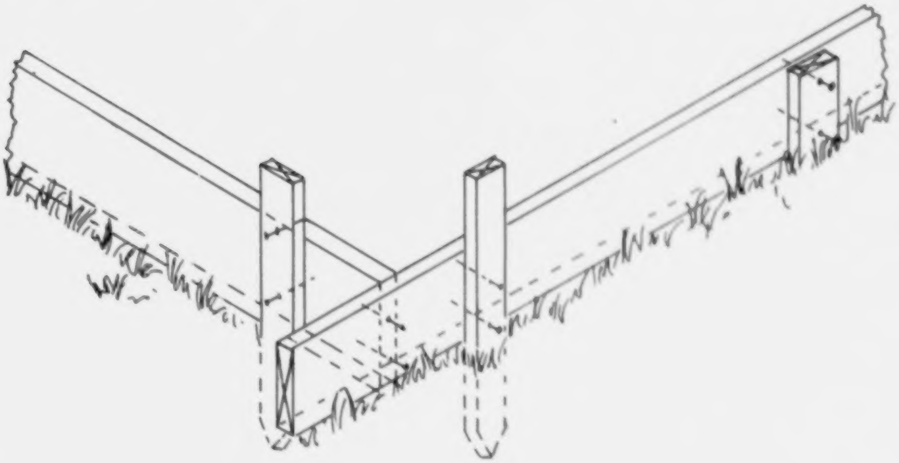
J. Nail 2×10 sheathing to stakes, with top of 2×10 flush with grade on stakes (Figure 17)

FIGURE 17


FORM FLUSH WITH STAKE
FORM SIDE

K. Tie all corners together as shown in Figure 18

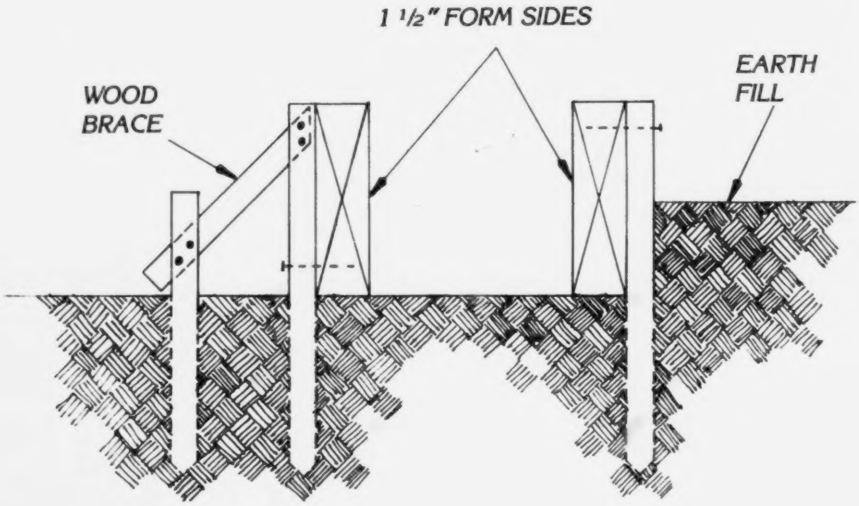
FIGURE 18



JOB SHEET #1

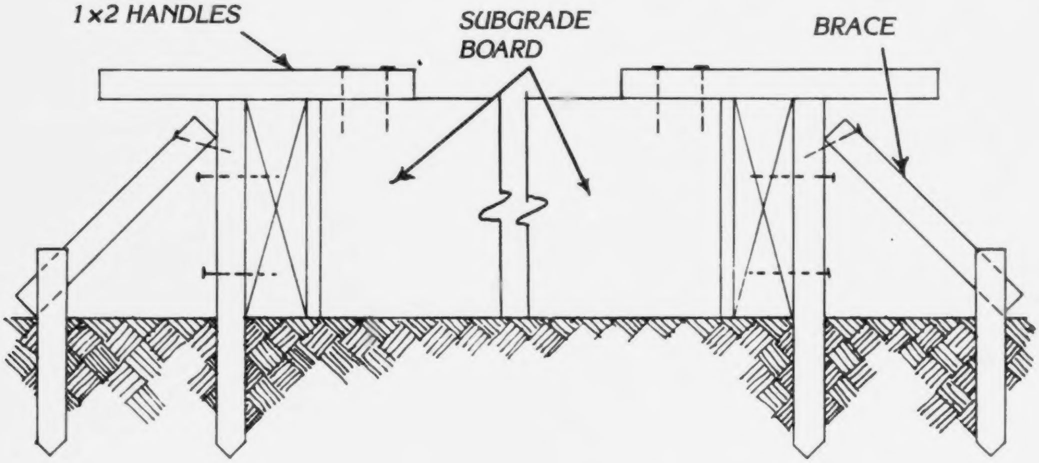
L. Brace the forms by one of the methods shown in Figure 19

FIGURE 19


1 1/2" FORM SIDES
WOOD BRACE
EARTH FILL

M. Make grade board as shown in Figures 20 and 21

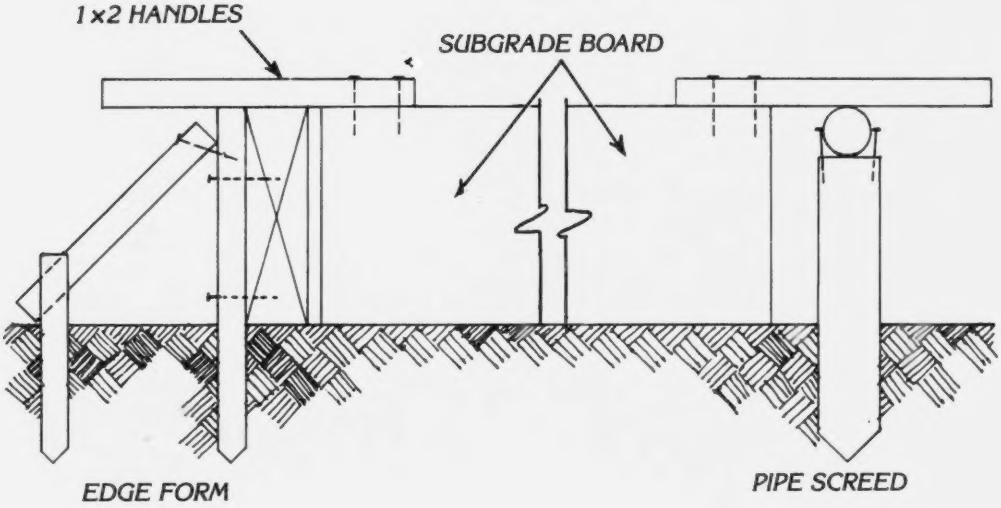
FIGURE 20


1×2 HANDLES
SUBGRADE BOARD
BRACE

JOB SHEET #1

(NOTE: On wide buildings, it will be necessary to set a temporary screed. See Figure 21.)

FIGURE 21


1x2 HANDLES
SUBGRADE BOARD
EDGE FORM
PIPE SCREED

EDGE FORMS ON GRADE
UNIT III

JOB SHEET #2 — CONSTRUCT EDGE FORMS FOR A SLAB ON GRADE WITH FOUNDATION

I. Tools and materials

   A. Sledge hammer

   B. Claw hammer

   C. Power handsaw and extension cord

   D. Handsaw

   E. One-hundred-foot tape

   F. Folding rule or steel tape

   G. Hand level

   H. String line

   I. Chalkline

   J. Builder's level and rod

   K. Plumb bob

   L. Stakes

   M. Sheathing

   N. 8d and 16d duplex nails

   O. #9 annealed wire

   P. Dowels

II. Procedure

   A. Lay sheathing on top of the wall or on the ground

   (NOTE: This is to establish location of support stakes.)

   B. Drive support stakes at ends of each sheathing board (Figure 22)

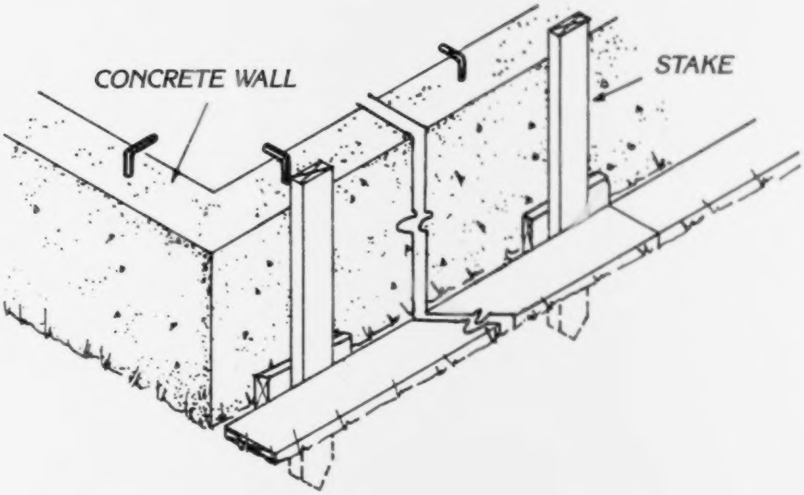
      1. Place a spacer block between stake and wall.

      2. Hold stake tightly against spacer block while driving.

      3. Drive until top of stake is slightly above finish slab grade.

JOB SHEET #2

FIGURE 22



C. Use builder's level to establish grade from bench mark on support stakes

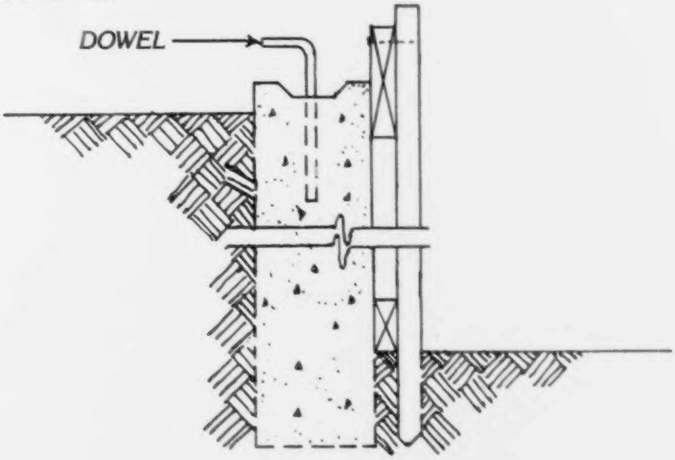
D. Nail sheathing to stakes (Figure 23)

   1. Drive a nail on inside of sheathing, a little less than height of grade mark on stake and foundation.

   2. Set sheathing in position.

   3. Raise sheathing to grade mark and nail.

FIGURE 23



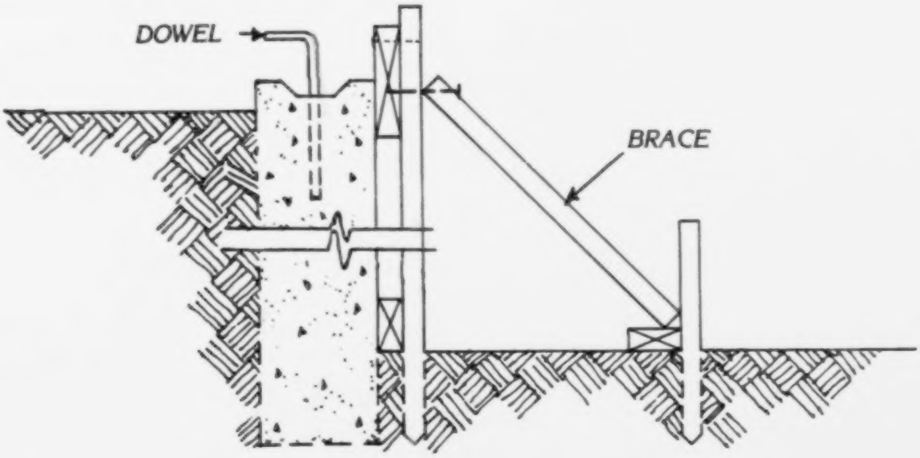
JOB SHEET #2

E. Drive intermediate stakes

F. Secure sheathing tightly against the wall (Figures 24 and 25)

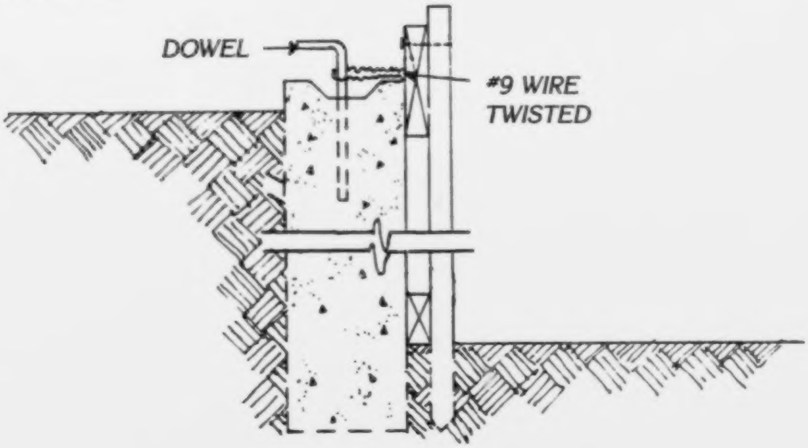
(NOTE: Figures 24 and 25 show alternate methods of holding the form against the wall and plumb. There could be situations where they would both be used on the same form.)

FIGURE 24



BRACE METHOD

FIGURE 25



TIE METHOD

G. Cut stakes off flush with top of edge form on surfaces where straight edge will be used

EDGE FORMS ON GRADE
UNIT III

JOB SHEET #3 — CONSTRUCT EDGE FORMS FOR A PATIO

I. Tools and materials

  A. Sledge hammer

  B. Claw hammer

  C. Power handsaw and extension cord

  D. Handsaw

  E. One-hundred-foot tape

  F. Folding rule or steel tape

  G. Hand level

  H. String line

  I. Builder's level and rod

  J. Drawings or sizes furnished by instructor

  K. Stakes

  L. 2×6s and hard board for radius

  M. Nails 6d box, 8d and 16d duplex nails

  N. 1×4s or 2×4s for braces

II. Procedure

  A. Locate form lines for slab (established by instructor)

  B. Drive corner line stakes, allowing for thickness of forms

  C. Lay out forms along this line, keeping ends butted together

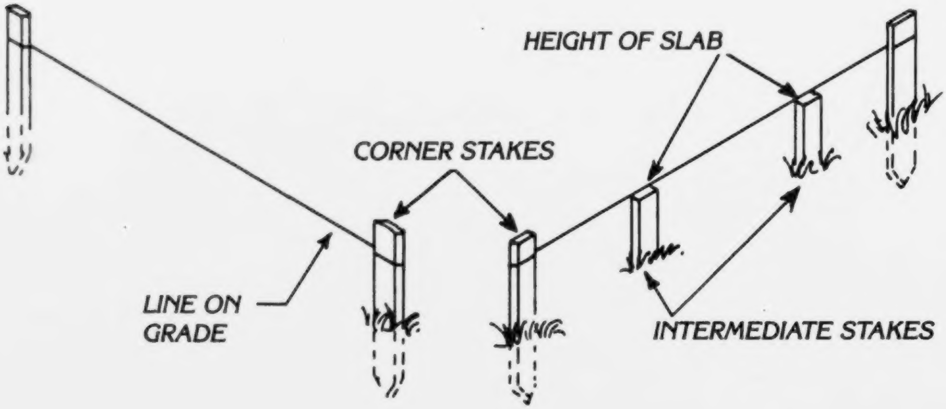
  D. Establish grade on line stakes, remembering to allow for $1\frac{1}{2}$-inch slope from building to outer edge of slab

JOB SHEET #3

E. Secure line to one corner stake on established grade and stretch line tight to the established grade on next corner stake (Figure 26)

(NOTE: Be sure that line is tight and that there is no sag in the line.)

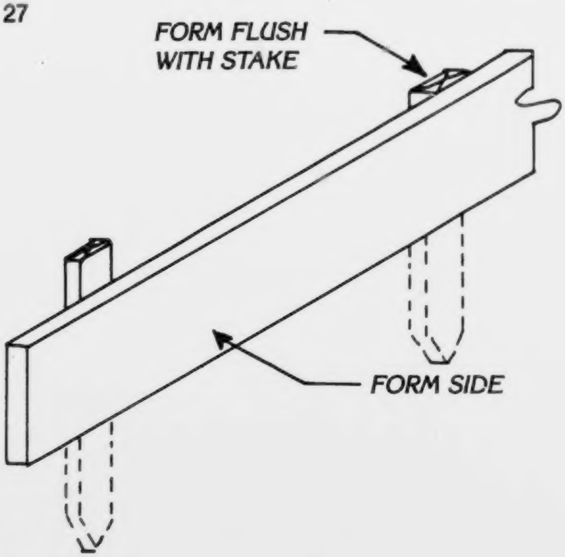
FIGURE 26


HEIGHT OF SLAB
CORNER STAKES
LINE ON GRADE
INTERMEDIATE STAKES

F. Drive all intermediate stakes straight down, with face of the stake plumb with line and the top of stake flush with line

G. Nail 2×6s sheathing to stakes with top of 2×6s flush with grade on stakes

FIGURE 27

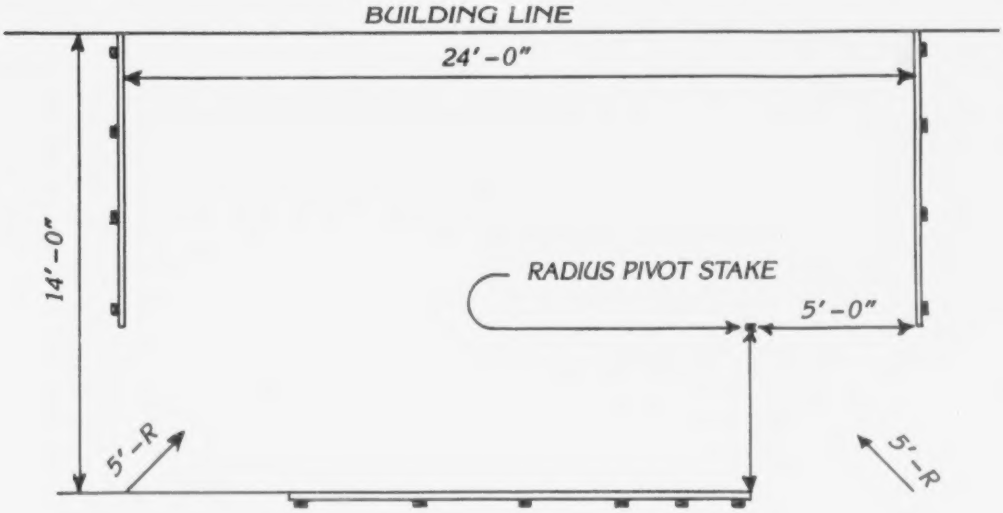

FORM FLUSH WITH STAKE
FORM SIDE

JOB SHEET #3

H. Lay out radius pivot stakes (Figure 28)

1. Measure at right angles from the two forms the correct distance of radius (5'-0")
2. Drive radius stake where 5-foot measurements intersect
3. Check measurements again, and drive a nail into top of stake at exact point where 5-foot measurements intersect

FIGURE 28



4. Use the same procedures to lay out second radius pivot stake

I. Drive stakes for radius (Figure 29)

1. Hook end of tape on nail in pivot stake
2. Stretch tape to both forms and check measurement

   (NOTE: If adjustment is necessary, force the stake over enough to compensate for difference.)

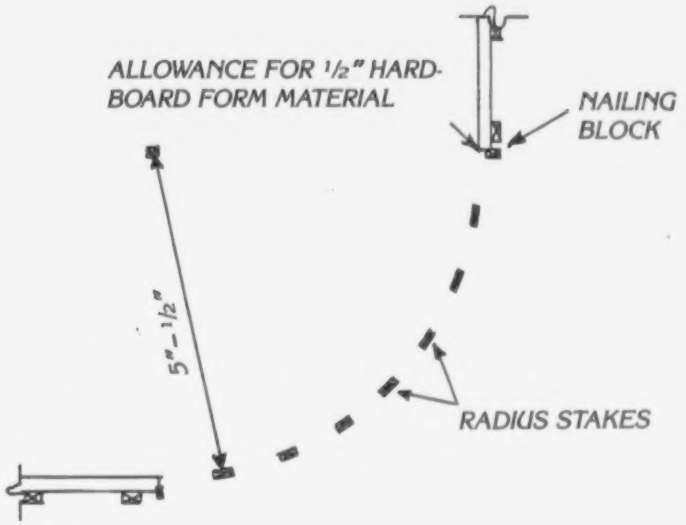
3. Keep tape stretched tight and move around radius from one form to the other, driving stakes centered about 12 inches apart

   (NOTE: Be sure to allow for the thickness of the form. Keep stakes plumb with the face of stakes flat to the radius.)

4. Use same procedures to drive stakes for second radius

JOB SHEET #3

FIGURE 29


ALLOWANCE FOR 1/2" HARD-BOARD FORM MATERIAL
NAILING BLOCK
5"–1/2"
RADIUS STAKES

J. Nail a nailing block on end of each straight form, allowing for thickness of radius form material (See Figure 29)

K. Establish grade on radius stakes

L. Nail hardboard to stakes

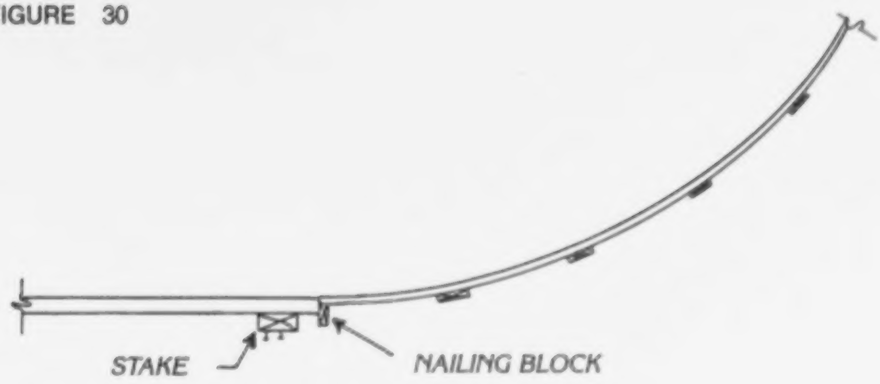
(NOTE: With this size radius, use two thicknesses of 1/4-inch hardboard with staggered joints.)

1. Hold the two pieces of hardboard flush on top, and start nailing from nailing block on one of straight forms

   (NOTE: Tie forms together as illustrated in Figure 30.)

JOB SHEET #3

FIGURE 30

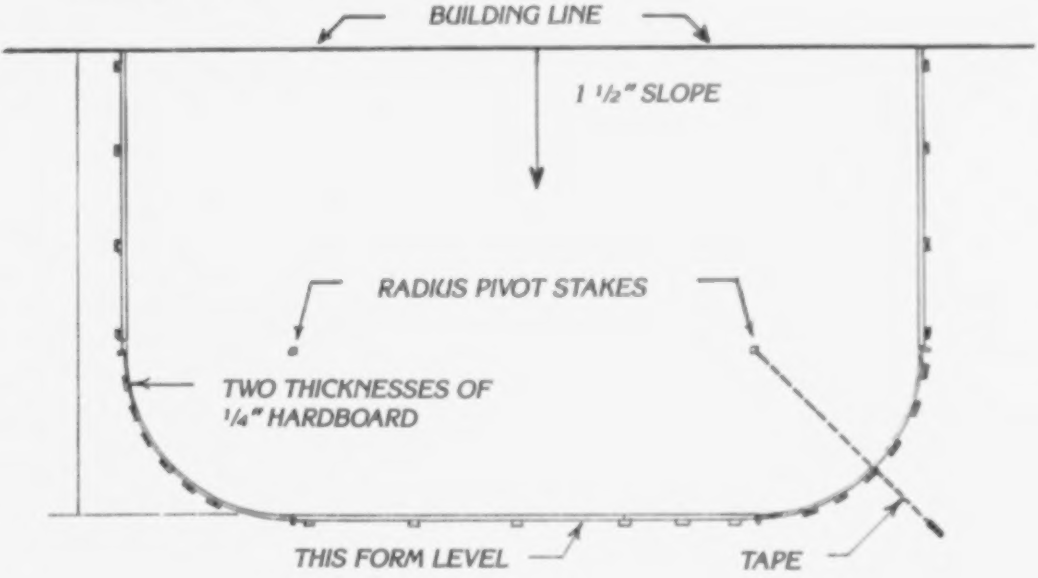

STAKE
NAILING BLOCK

2. Continue working around radius, keeping top edge of form on grade and adding pieces of hardboard as necessary until radius is complete.

   (NOTE: If joints in hardboard do not center on stakes, drive an intermediate stake.)

M. Use same procedures to nail forms on second radius (Figure 31)

FIGURE 31

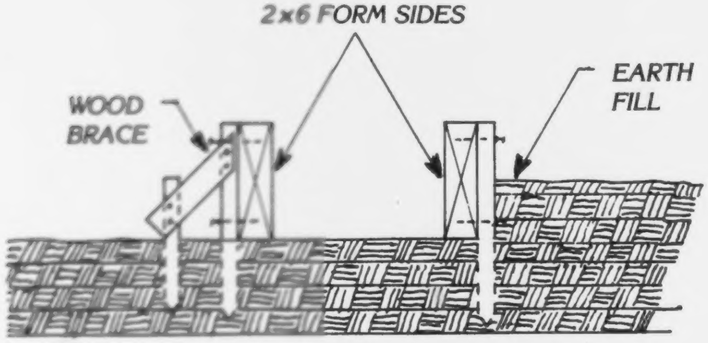

BUILDING LINE
1 ½" SLOPE
RADIUS PIVOT STAKES
TWO THICKNESSES OF ¼" HARDBOARD
THIS FORM LEVEL
TAPE

JOB SHEET #3

N. Brace forms using one of the methods illustrated in Figure 32

(NOTE: Any stakes sticking up above the forms may be cut off flush with the top of form.)

FIGURE 32


2x6 FORM SIDES
WOOD BRACE
EARTH FILL

EDGE FORMS ON GRADE
UNIT III

JOB SHEET #4 — CONSTRUCT EDGE FORMS FOR A SIDEWALK

I. Tools and materials

- A. Sledge hammer
- B. Claw hammer
- C. Power handsaw and extension cord
- D. Handsaw
- E. One-hundred-foot tape
- F. Folding rule or steel tape
- G. Hand level
- H. String line
- I. Builder's level and rod
- J. Stakes
- K. 2×4s for sheathing
- L. 8d and 16d duplex nails

II. Procedure

(NOTE: The sidewalk will be 4′-0″ × 24′-0″ × 4″.)

- A. Establish sidewalk location

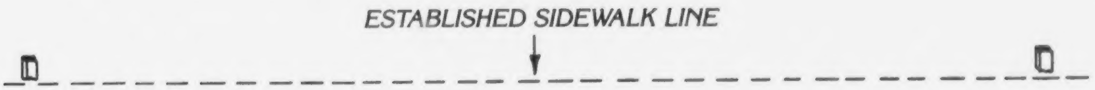
  (NOTE: Check with your instructor.)

- B. Set form stakes for one side of sidewalk
  1. Locate side you are going to set first
  2. Drive line stakes at each end of this line, approximately 24 feet apart (Figure 33)

     (NOTE: Be sure to allow for the thickness of the forms when setting line stakes.)

JOB SHEET #4

FIGURE 33

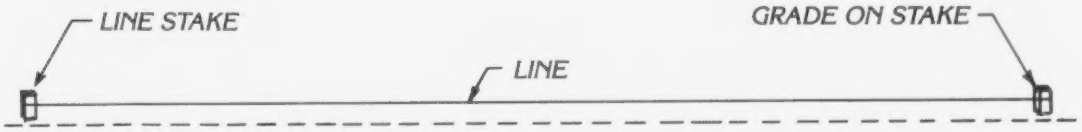

ESTABLISHED SIDEWALK LINE

3. Establish sidewalk grade on the two line stakes

4. Secure line to one line stake on established grade and stretch line tight to the established grade on stake at opposite end (Figure 34)

   (NOTE: Be sure that line is tight and that there is no sag in it.)

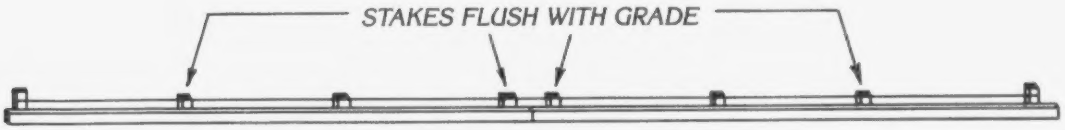
FIGURE 34


LINE STAKE
LINE
GRADE ON STAKE

5. Lay out forms for this section of sidewalk, starting at one end and laying them end to end

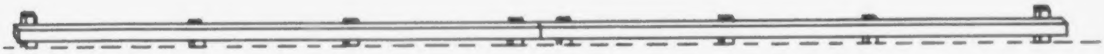
6. Drive all intermediate stakes 3 to 3½ feet apart; drive stakes straight down with face of stake plumb with line and top of stake flush with line (Figure 35)

FIGURE 35


STAKES FLUSH WITH GRADE

C. Nail 2×4 sheathing to stakes with top of 2×4 flush with top of stakes or flush with grade on stakes (Figure 36)

FIGURE 36



JOB SHEET #4

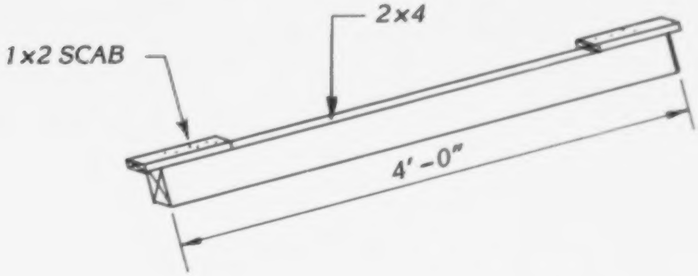
D. Align form and brace if necessary

(NOTE: Use one of the methods shown in Figure 19 of Job Sheet #1.)

E. Construct two spreaders to use to set stakes on opposite side of sidewalk

(NOTE: This spreader can also be used to establish the subgrade. See Figure 37.)

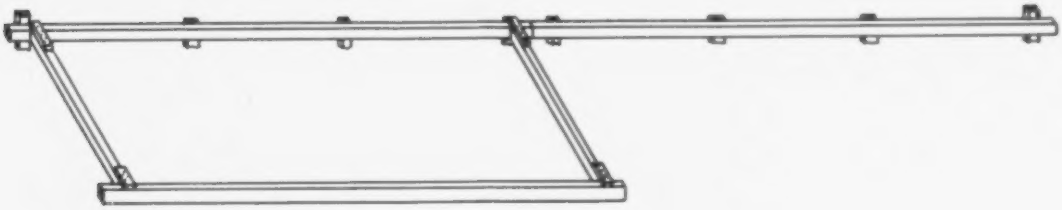
FIGURE 37



F. Set form stakes for opposite side of sidewalk

1. Lay out forms for this section of sidewalk, starting even with one end of the completed form and laying forms end to end
2. Lay one end of each spreader between erected form and loose forms, snugging them together (Figure 38)

FIGURE 38



3. With form held in place, drive stakes opposite those in erected form; drive stakes straight down with solid blows of the sledge hammer

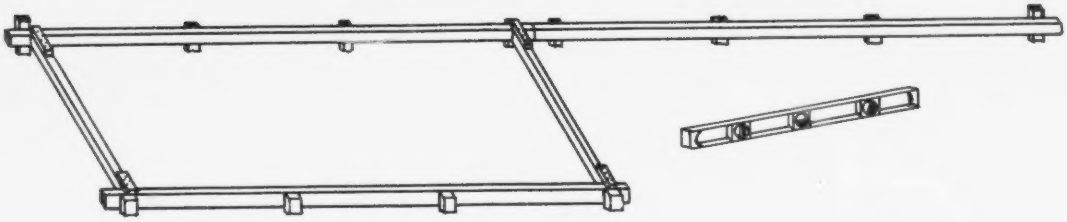
   (NOTE: If the stakes are not driven straight down, the other form will be forced out of alignment.)

JOB SHEET #4

4. Establish grade by placing hand level on top of spreader board (Figure 39)

   (NOTE: Check with instructor for grade on this form.)

FIGURE 39



5. Drive stakes down to grade
6. Nail 2×4 sheathing to stakes with top of form flush with top of stake
7. Continue these procedures to complete second side of form

G. Align second side of the form, maintaining 4′-0″ between the two

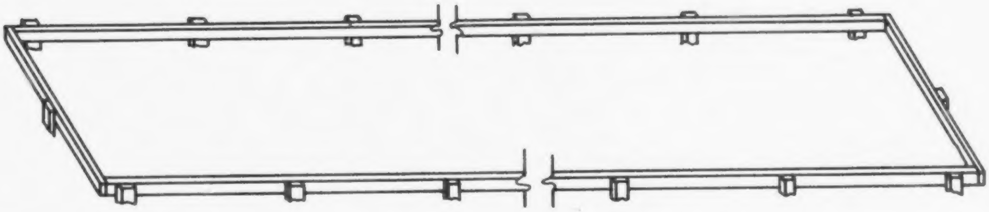
H. Cut two 2×4s long enough (at least 4′-3″) to go across ends of forms for bulkheads

I. Nail bulkheads in place, with tops of bulkheads flush with top of both side forms.

J. Drive a stake at the center of each bulkhead to keep the concrete from forcing bulkheads out (Figure 40)

(NOTE: A scab can be nailed across the joint where the two forms butt each other or they may be toenailed together.)

FIGURE 40



EDGE FORMS ON GRADE
UNIT III

JOB SHEET #5 — SET PIPE SCREEDS WITH BUILDER'S LEVEL AND ROD

I. Tools and materials

A. Sledge hammer

B. Claw hammer

C. Folding rule or tape

D. String line

E. Builder's level and rod

F. 1½" diameter pipe

G. ¾" × 3" × 15" stakes

H. 8d common nails

II. Procedure

(NOTE: There are various types of screeds that may be used; basically they will be set the same way.)

A. Establish screed location (Figure 41)

1. Measure across one end of forms to determine width of pour (28′-0″)

2. Divide area into three equal parts (9′-4″)

3. Mark location of end stakes on form at each end

B. Set stake at each end of screed location

C. Stretch string line between two stakes from point 1 to point 2

(NOTE: The line is used as a guide to drive stakes in a straight line and at an approximate grade.)

D. Drive stakes approximately 4 feet apart

(NOTE: The distance between stakes will vary according to the size of pipe. They should be placed closer together for small-diameter pipe.)

E. Set builder's level and establish grade

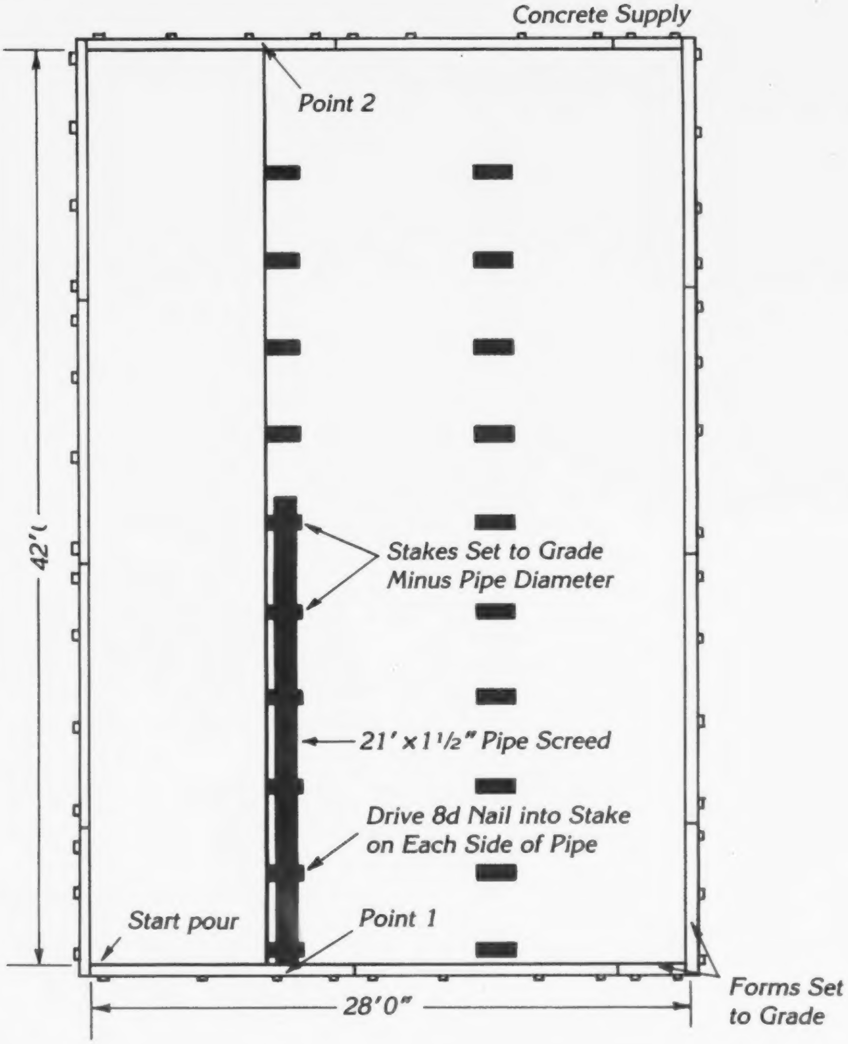
JOB SHEET #5

F. Use level and rod and drive stakes 1½ inches below finish floor grade (thickness of pipe) (Figure 42)

G. Place pipe on stakes and drive 8d nails into stakes on each side of pipe screed to hold it in position

H. Take shots at various points on top of pipe to spot check screed grade

FIGURE 41

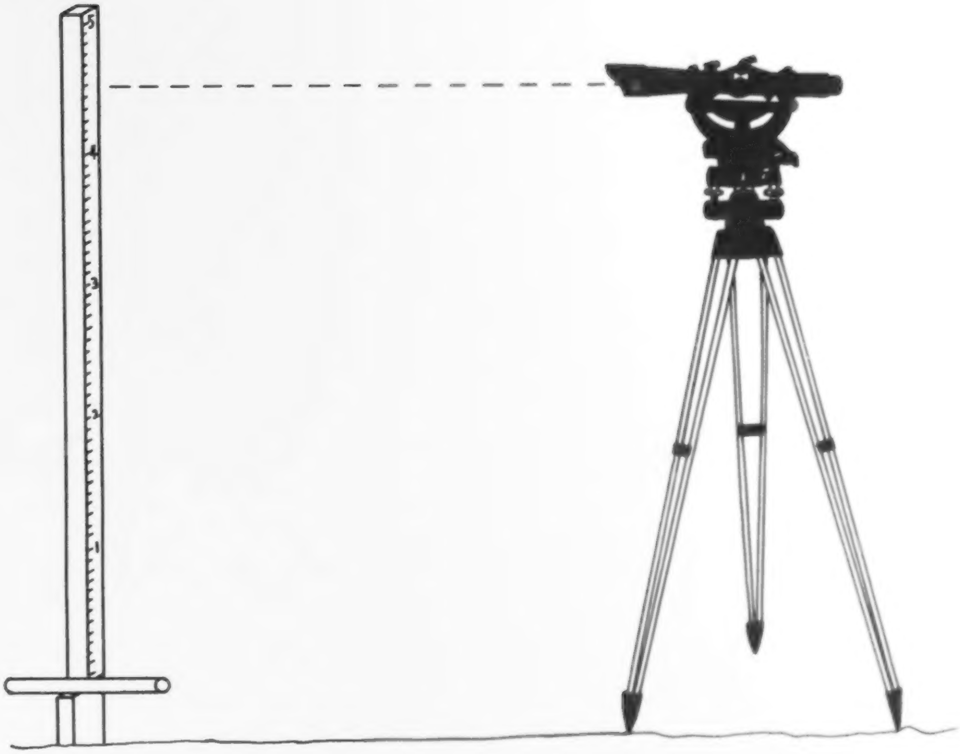


Concrete Supply
Point 2
Stakes Set to Grade Minus Pipe Diameter
21' x 1½" Pipe Screed
Drive 8d Nail into Stake on Each Side of Pipe
Start pour
Point 1
42'
28'0"
Forms Set to Grade

(NOTE: Stakes and pipe enlarged for clarity.)

JOB SHEET #5

FIGURE 42



EDGE FORMS ON GRADE
UNIT III

TEST

NAME ______________________________ SCORE ______________

1. Match to their correct definitions terms associated with on-grade edge forms. Write the correct numbers in the blanks.

______a. Low form placed at perimeter of slab

______b. Piece of wood or other material that directs, resists, or supports weight or pressure

______c. Level of finished concrete in a form

______d. Continuous mass of concrete cast as a single unit

______e. Wood or metal that makes up face of the form

______f. Preformed piece of fibrous or asphaltic material used to separate units of concrete to prevent cracking due to expansion

______g. Temporary guide used for rodding concrete to a finish grade

______h. Section of concrete larger in its horizontal dimensions than in thickness

______i. Double-headed nail used in forming and designed for easy removal

______j. That portion of a wall, including the footing, upon which building rests

______k. Small boards or steel bars sharpended on one end and driven into ground to help support a form

______l. Short piece of steel bar inserted through a bulkhead to tie adjoining pours together

______m. Piece of material nailed across a splice to strengthen and hold it together

______n. Tool or device attached to a string; used to set and/or check plumb or perpendicular of a surface

______o. Wire or metal cross tie used to hold the pressure of wet concrete and maintain proper wall thickness

1. Sheathing
2. Brace
3. Duplex nail
4. Expansion joint
5. Monolithic pour
6. Foundation
7. Edge form
8. Grade point
9. Screed
10. Slab
11. Stakes
12. Scab
13. Plumb bob
14. Form tie
15. Dowel

TEST

2. Identify the parts of an edge form illustrated below. Write the correct numbers in the blanks.

______a. Stake

______b. Sheathing

______c. Brace

______d. Scab

______e. Duplex nail

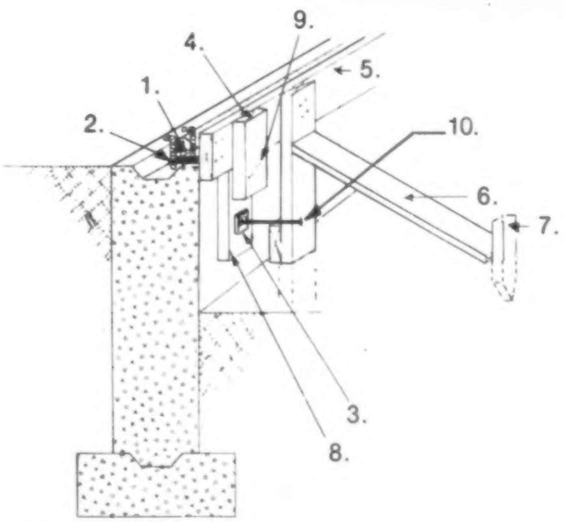
______f. Block

______g. Support block

______h. Kicker

______i. Form tie

______j. #9 tie wire



3. Name three types of pours using edge forms.

a. ______________________________

b. ______________________________

c. ______________________________

4. List types of materials used to construct edge forms.

a. ______________________________

b. ______________________________

c. ______________________________

5. Distinguish between screeds and bulkheads. Write an "S" in the blanks before correct statements about screeds and a "B" in the blanks before correct statements about bulkheads.

______a. Remove after concrete has set

______b. Usually set no more than twelve feet apart

______c. Form used to contain concrete and to cut off concrete pour

______d. Can be used as a guide for rodding (dragging off) concrete to a finish grade

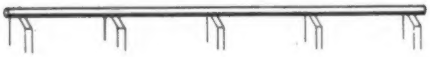
______e. Removed after concrete is poured

______f. Temporary guide set to grade, used for rodding (dragging off) concrete to a finish grade

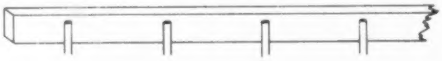
TEST

6. Identify types of screeds illustrated below. Write the correct names in the blanks.

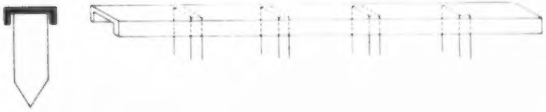
Wood screed with metal stakes
Pipe screed with adjustable screed chairs
Steel channel with wood stakes
Wood screed with wood stakes
Steel bar with metal stake and bracket
Pipe screed with wood stakes



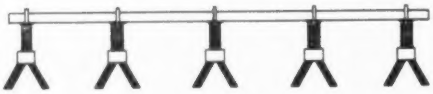
a. ______________________________



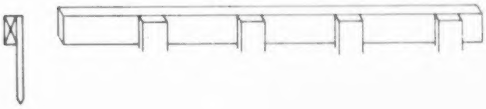
b. ______________________________



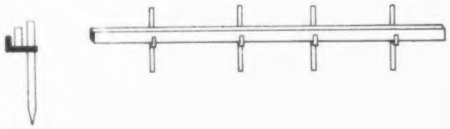
c. ______________________________



d. ______________________________



e. ______________________________



f. ______________________________

(NOTE: Test question 7 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

7. Demonstrate ability to

   a. Construct edge forms for a slab on grade without foundation.

   b. Construct edge forms for a slab on grade with foundation.

   c. Construct edge forms for a patio.

   d. Construct edge forms for a sidewalk.

   e. Set screeds for a floor slab.

EDGE FORMS ON GRADE
UNIT III

ANSWERS TO TEST

1. a. 7
   b. 2
   c. 8
   d. 5
   e. 1
   f. 4
   g. 9
   h. 10
   i. 3
   j. 6
   k. 11
   l. 15
   m. 12
   n. 13
   o. 14

2. a. 7
   b. 5
   c. 6
   d. 4
   e. 9
   f. 3
   g. 8
   h. 2
   i. 10
   j. 1

3. Any three of the following is correct.

   a. Floor with foundation
   b. Floor without foundation
   c. Parking lots and air strips
   d. Driveways and streets
   e. Sidewalks
   f. Approaches

4. a. Wood
   b. Metal
   c. Combination wood and metal

5. a. B
   b. S
   c. B
   d. B
   e. S
   f. S

6. a. Pipe screed with wood stakes
   b. Wood screed with metal stakes
   c. Steel channel with wood stakes
   d. Pipe screed with adjustable screed chairs
   e. Wood screed with wood stakes
   f. Steel bar with metal stakes and bracket

7. Performance skills evaluated to the satisfaction of the instructor

WALL FORMS
UNIT IV

UNIT OBJECTIVE

After completing this unit, the student should be able to identify parts of a wall form, estimate materials needed to build a form, and should be able to construct various types of wall forms. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with wall forms.
2. Name types of wall forms.
3. Select from a list types of materials used to construct wall forms.
4. Identify parts of a wall form.
5. Select from a list advantages of patented form panels over built-in-place or erected-in-place forms.
6. Estimate width of panels and the required number of each size.
7. Demonstrate the ability to
    a. Construct straight wall with patented forms.
    b. Construct gang forms for a battered wall.
    c. Construct circular wall forms built in place.
    d. Construct panel forms.
    e. Remove forms and prepare for storage.

WALL FORMS
UNIT IV

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Transparency masters

      1. TM #1 — Parts of a Form

      2. TM #2 — Foundation Plan

      3. TM #3 — Section A of Foundation Plan

      4. TM #4 — Section B of Foundation Plan

      5. TM #5 — Typical Pilaster Form

      6. TM #6 — Panel Layout and Sizes

   D. Job sheets

      1. Job Sheet #1 — Construct a Straight Wall with Patented Forms

      2. Job Sheet #2 — Construct Gang Forms for a Battered Wall

      3. Job Sheet #3 — Construct Circular Wall Forms Built in Place

      4. Job Sheet #4 — Construct Panel Forms

      5. Job Sheet #5 — Remove Forms and Prepare for Storage

   E. Test

   F. Answers to test

II. Instructor's guide

   A. Review unit and plan presentation.

   B. Order or obtain materials to supplement unit.

      1. Equipment and materials for procedures outlined in job sheets

      2. Transparencies and competency profiles

SUGGESTED ACTIVITIES

(NOTE: The transparencies and competency profiles for this manual are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

C. Introduce unit.

SUGGESTIONS:

- Stress the importance of good, solid forms.
- Explain the differences among forms and discuss reasons why a particular type of form is used above other forms.
- Explain the different methods, techniques, and materials used in different forms and by different contractors.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

1. Use Information Sheet, Section I to discuss terms and definitions associated with wall forms.

   SUGGESTION:

   - Show students examples of appropriate terms.

2. Use Information Sheet, Section II to introduce students to types of wall forms.

   SUGGESTIONS:

   - Take students on a tour of appropriate construction sites in the community and point out the different types of wall forms.
   - Have students examine various wall forms and note their differences.

3. Use Information Sheet, Section III to discuss materials needed to construct wall forms.

   SUGGESTION:

   - Show students wall forms constructed with each of the materials listed in this section.

SUGGESTED ACTIVITIES

4. Use Information Sheet, Section IV to acquaint students with the various parts of a wall form.

   SUGGESTIONS:

   - Use Transparency #1 to illustrate your discussion.
   - Have students identify the parts of an actual form.

5. Use Information Sheet, Section V to discuss the advantages of gang and panel forms over built-in-place or erected-in-place forms.

6. Use Information Sheet, Sections VI and VII to explain how to estimate materials and panel widths and numbers.

   SUGGESTIONS:

   - Use Transparencies #2 through #6 to illustrate your discussion.
   - Have students use dimensions and specifications on Transparencies #2 through #6 to estimate material needed to build a form specified.
   - Have students use the dimensions and specifications on these transparencies to estimate panel widths and required numbers of each size.

7. Demonstrate and discuss procedures outlined in Job Sheets #1 through #5. Have students complete Job Sheets #1 through #5.

H. Give test.

I. Critique test and discuss in class.

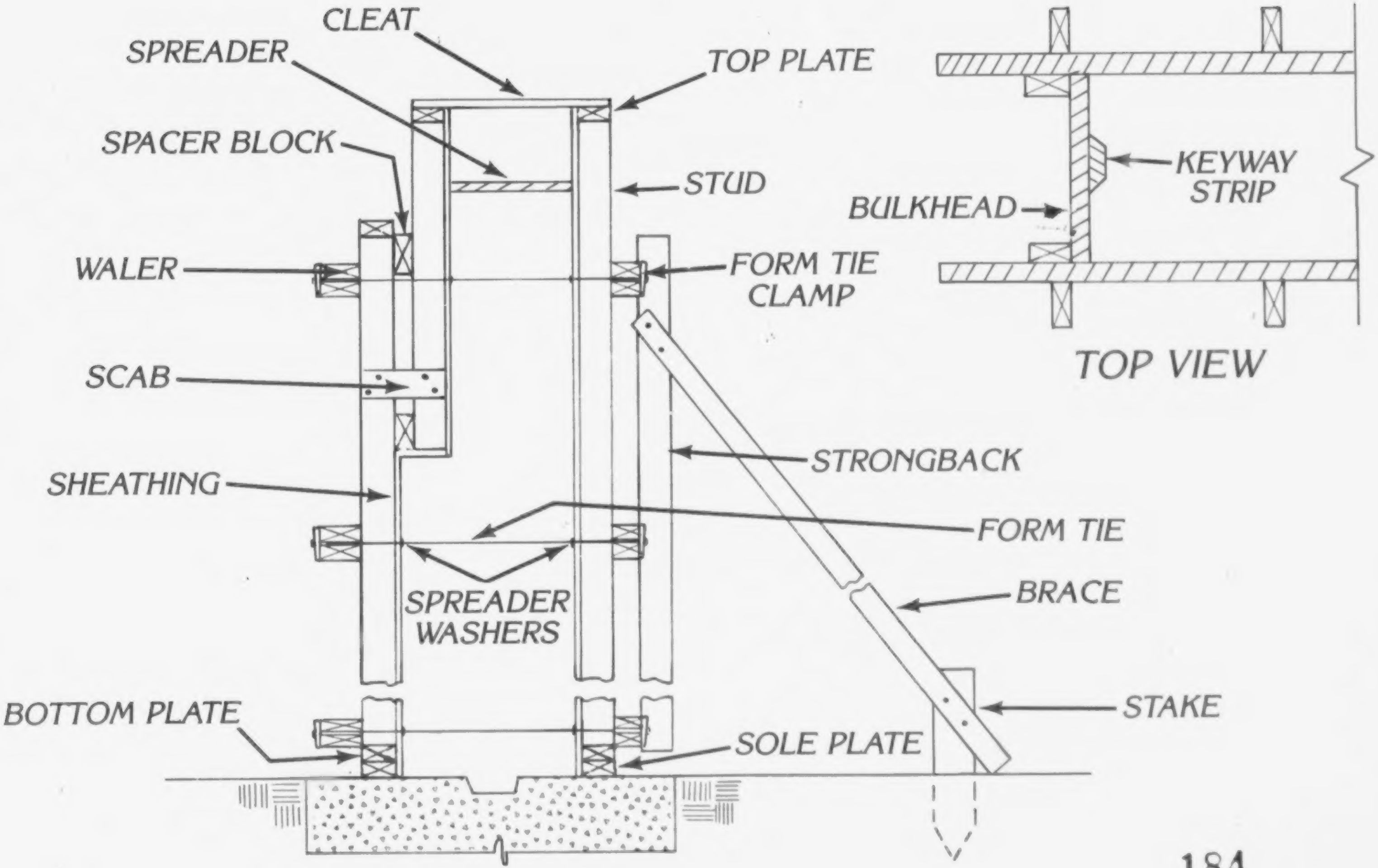
J. Reteach and retest if necessary.

K. Complete appropriate section of competency profiles.

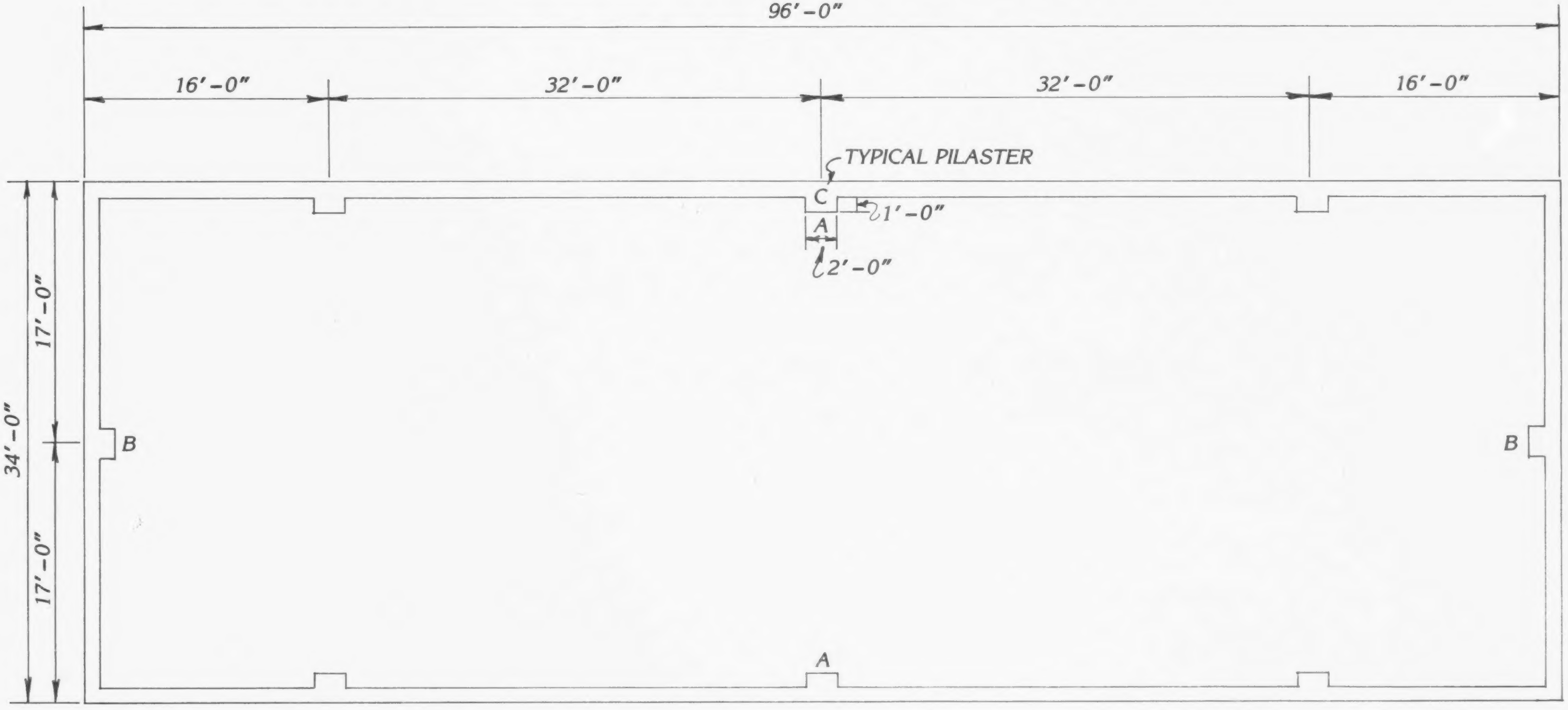
III. Unit references

A. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

Parts of a Wall Form

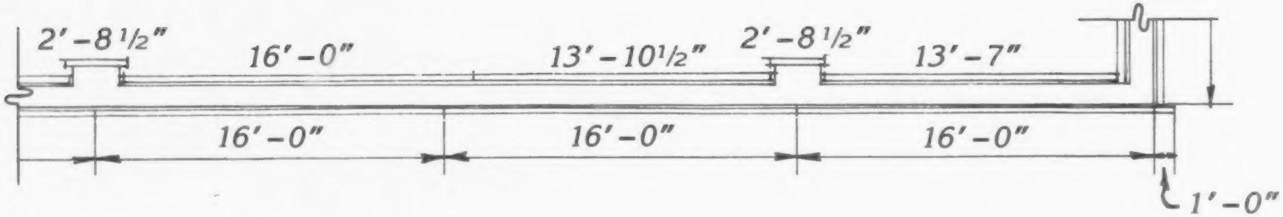

CLEAT
SPREADER
TOP PLATE
SPACER BLOCK
STUD
WALER
FORM TIE CLAMP
SCAB
STRONGBACK
SHEATHING
FORM TIE
SPREADER WASHERS
BRACE
BOTTOM PLATE
STAKE
SOLE PLATE
KEYWAY STRIP
BULKHEAD
TOP VIEW

Foundation Plan


96'-0"
16'-0"
32'-0"
32'-0"
16'-0"
TYPICAL PILASTER
C
1'-0"
A
2'-0"
34'-0"
17'-0"
17'-0"
B
B
A

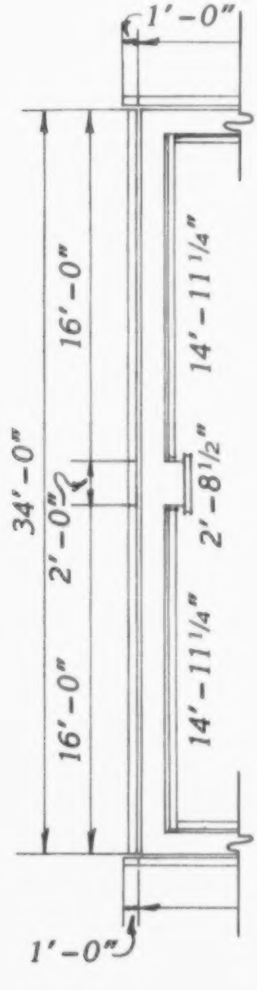
SCALE: 3/32" = 1'-0"

Detail of Panels for South Wall

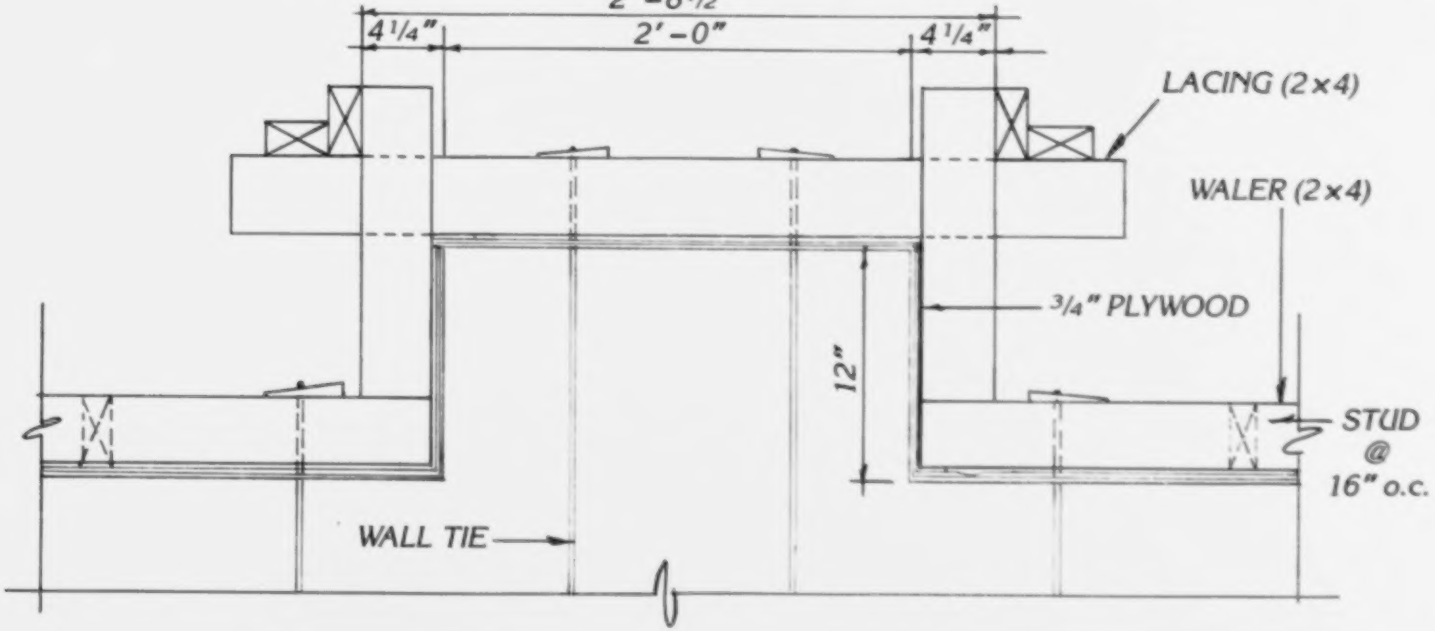

2'-8 1/2"
16'-0"
13'-10 1/2"
2'-8 1/2"
13'-7"
16'-0"
16'-0"
16'-0"
1'-0"

SCALE: 3/32" = 1'-0"

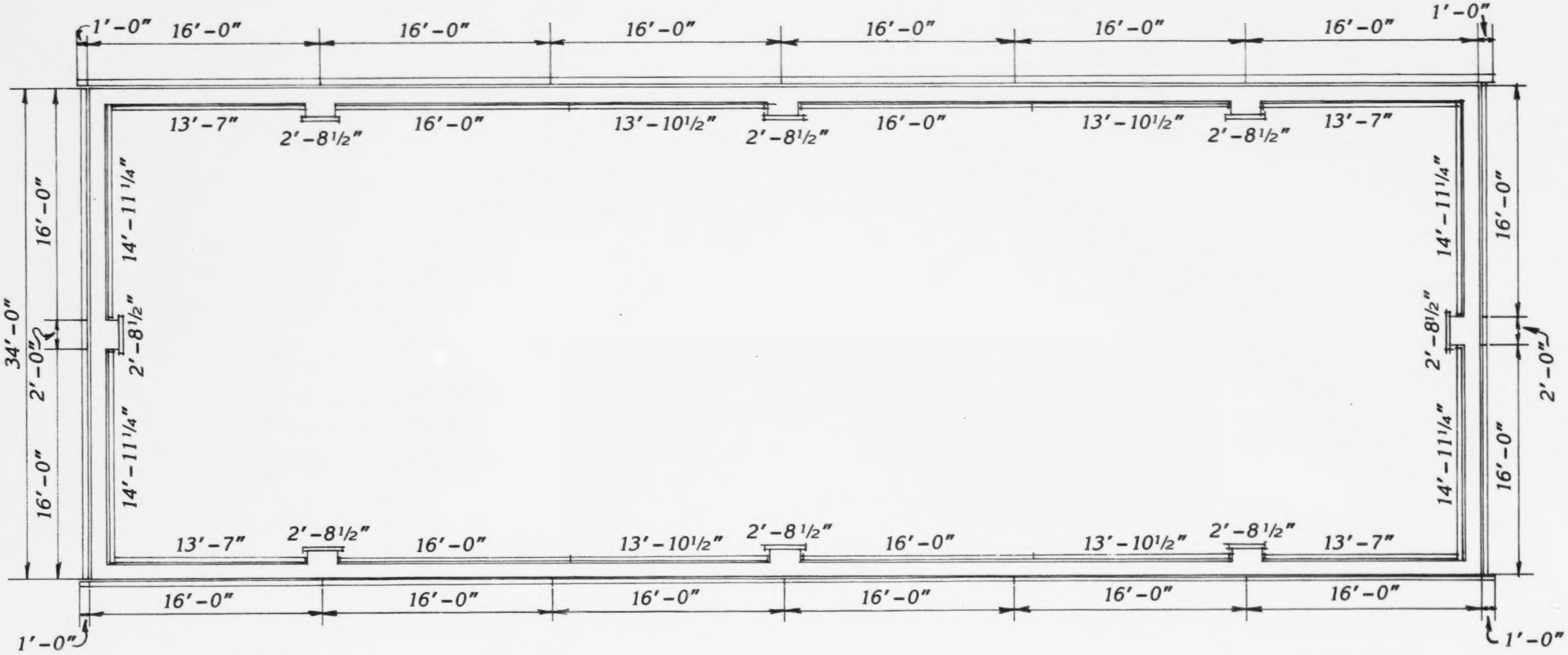
Details of Panels for End Walls


1'–0"
34'–0"
16'–0"
2'–0"
16'–0"
14'–11 1/4"
2'–8 1/2"
14'–11 1/4"
1'–0"

Typical Detail of Pilaster Form


2'-8½"
4¼"
2'-0"
4¼"
LACING (2×4)
WALER (2×4)
¾" PLYWOOD
12"
STUD @ 16" o.c.
WALL TIE

Panel Layout and Sizes


1'-0"
16'-0"
16'-0"
16'-0"
16'-0"
16'-0"
16'-0"
1'-0"
13'-7"
2'-8½"
16'-0"
13'-10½"
2'-8½"
16'-0"
13'-10½"
2'-8½"
13'-7"
34'-0"
16'-0"
2'-0"
16'-0"
14'-11¼"
2'-8½"
14'-11¼"
14'-11¼"
2'-8½"
14'-11¼"
16'-0"
2'-0"
16'-0"
13'-7"
2'-8½"
16'-0"
13'-10½"
2'-8½"
16'-0"
13'-10½"
2'-8½"
13'-7"
16'-0"
16'-0"
16'-0"
16'-0"
16'-0"
16'-0"
1'-0"
1'-0"

SCALE: 3/32" = 1'-0"

WALL FORMS
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Panel — Single section of a patented or job-built form

B. Gang forms — Prefabricated panels joined together to make a much larger unit, for convenience in erecting, stripping, and reusing

C. Prefabricated — Panel units that have been constructed or assembled prior to using

D. Cleat — Strip of wood or metal fastened across a form for temporary positioning or to replace a form tie

E. Form tie — Wire or metal cross tie used to hold the pressure of wet concrete and maintain the proper wall thickness

F. Keyway — Recess or groove in one lift or placement of the next lift, giving shear strength to the joint

G. Keyway strip — Beveled piece of wood or metal used in a form to form the keyway where future pours occur

H. Scab — Piece of material fastened across a splice to strengthen and hold the two pieces together

I. Spreader — Piece of wood cut to thickness of wall and inserted to hold forms temporarily at the correct dimension against tension of the form ties and removed as the pressure of the concrete permits

J. Bulkhead — Board placed in a form to cut off the concrete pour

K. Waler — Horizontal brace used in form construction

L. Pilaster — Vertical member that is part of the wall, projecting from the wall and treated as a column; usually projects a third or less of its width from the wall to help support the wall

M. Tag line — Line attached to load to help balance and guide load being hoisted

N. Battered wall — Wall with an inward slope from bottom to top of face of wall

O. Form oil — Blend of oils applied to interior surface of forms to prevent concrete from adhering to the forms

P. Water stop — Thin sheets of rubber, plastic or other material inserted in a construction joint to obstruct seepage of water through the joint

INFORMATION SHEET

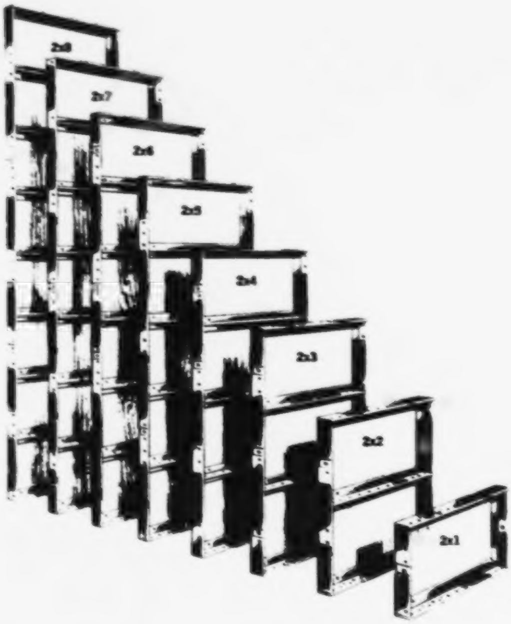
II. Types of forms (Figures 1-7)

A. Panel forms

1. Patented form panels

EXAMPLE:

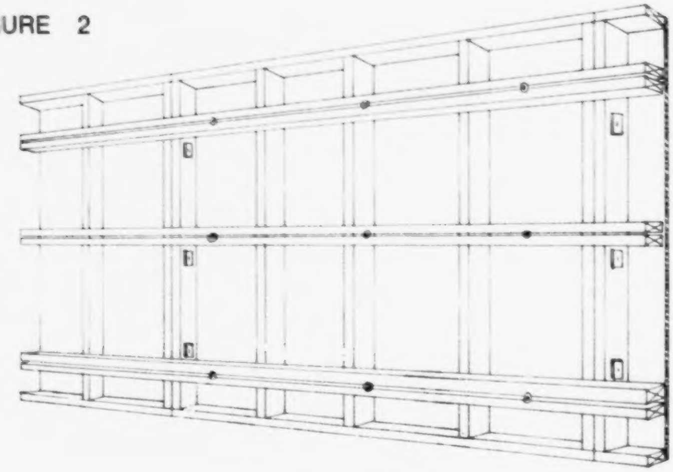
FIGURE 1


2x8
2x7
2x6
2x5
2x4
2x3
2x2
2x1

2. Job-built or shop-built form panel

EXAMPLE:

FIGURE 2

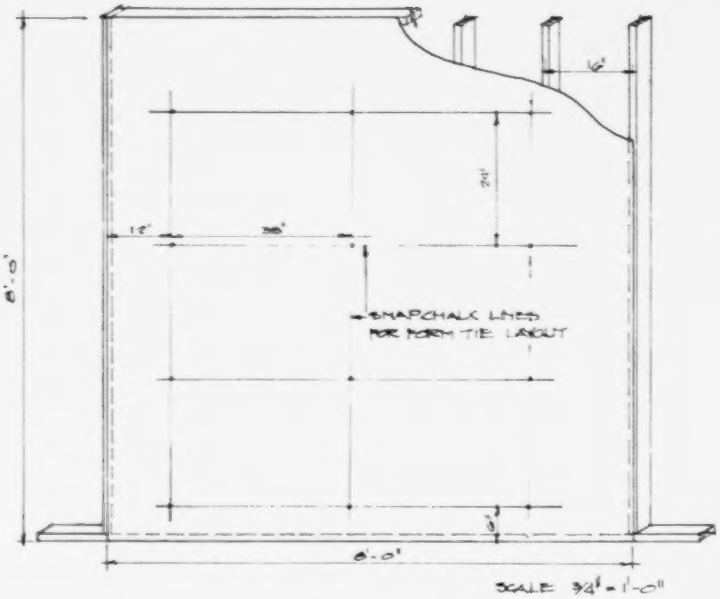


INFORMATION SHEET

B. Built-in-place wood form

EXAMPLE:

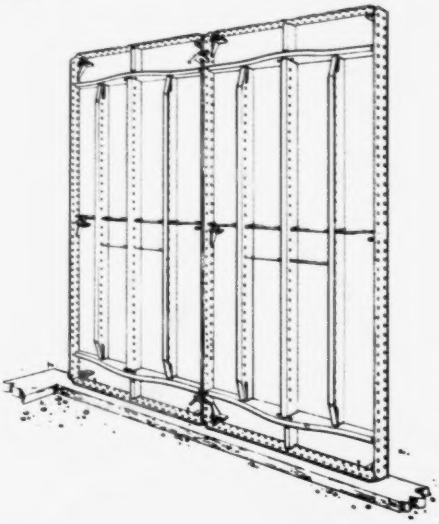
FIGURE 3


16"
24"
12"
36"
8'-0"
SNAPCHALK LINES FOR FORM TIE LAYOUT
8"
8'-0"
SCALE 3/4" = 1'-0"

C. Erected-in-place patented forms

EXAMPLE:

FIGURE 4



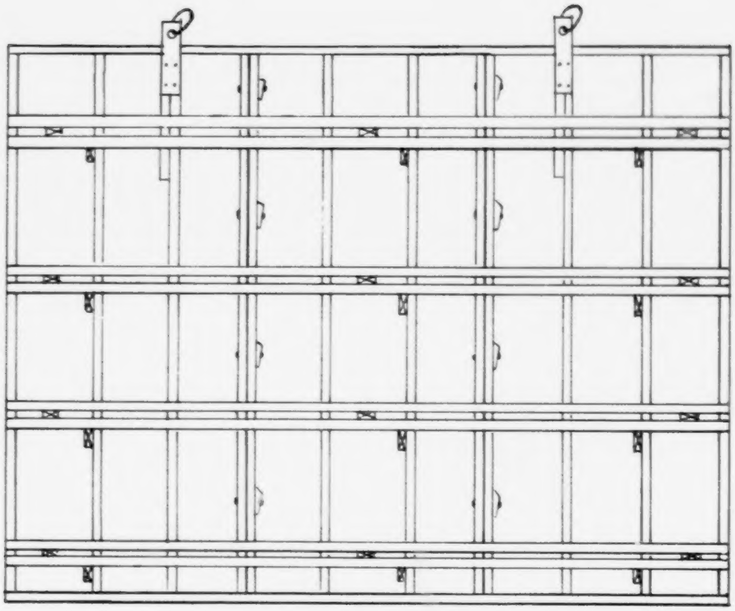
INFORMATION SHEET

D. Gang forms

1. Job-built wood form

EXAMPLE:

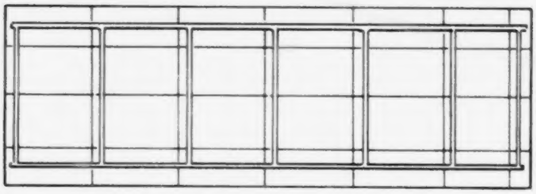
FIGURE 5



2. Patented panel form

EXAMPLE:

FIGURE 6

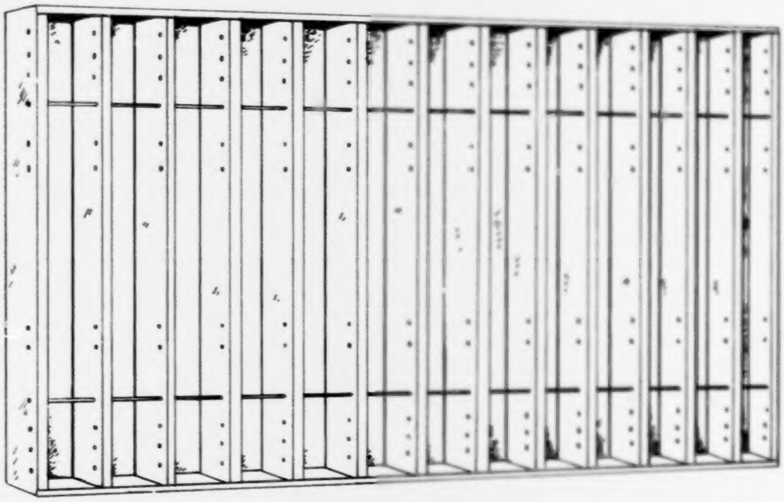


INFORMATION SHEET

E. Steel plate girder form

EXAMPLE:

FIGURE 7



III. Types of materials used to construct forms

A. Wood

B. Metal

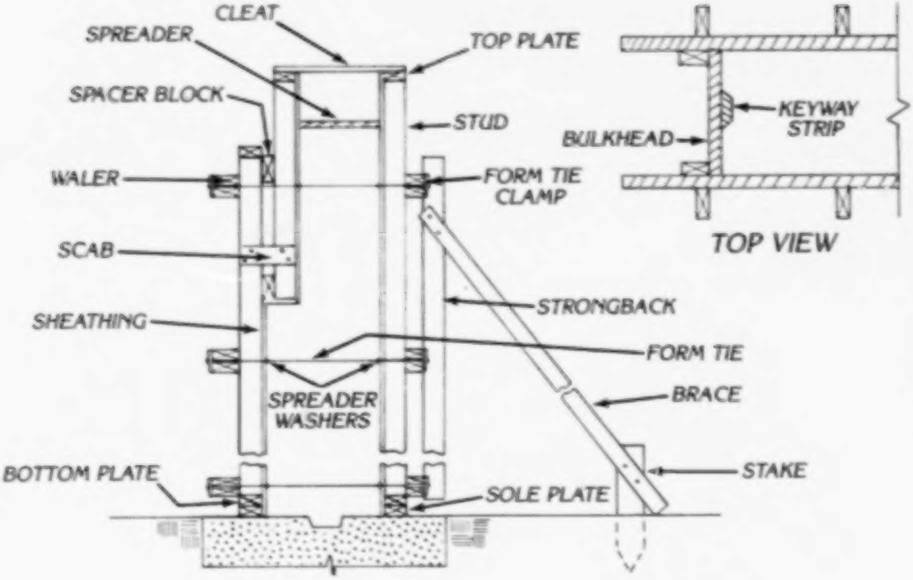
C. Fiberglass

D. Combination wood and metal

INFORMATION SHEET

IV. Parts of a basic wall form (Figure 8)

FIGURE 8


CLEAT
SPREADER
TOP PLATE
SPACER BLOCK
STUD
WALER
FORM TIE CLAMP
SCAB
STRONGBACK
SHEATHING
FORM TIE
BRACE
SPREADER WASHERS
BOTTOM PLATE
SOLE PLATE
STAKE
KEYWAY STRIP
BULKHEAD
TOP VIEW

V. Advantages of patented panel forms over built-in-place or erected-in-place forms

- A. Faster erection
- B. Faster stripping
- C. More reuses of materials
- D. Ensures a cleaner site

VI. Estimating width and number of panels

- A. Determine panel sizes by
  - 1. Ability to handle at the building and erection site
  - 2. Plan dimensions
  - 3. Cutting materials with the least amount of waste

INFORMATION SHEET

B. Determine sections of wall that will take identical panels

(NOTE: The examples refer to Figures 9 and 10 at the end of this section.)

EXAMPLES:

1. Pilaster spacing, north and south walls
2. East and west walls and the returns to the first pilaster

C. Determine panel sizes for first wall section (See Figure 9.)

EXAMPLES:

1. Main panels sixteen feet long

   (NOTE: Form plywood can be purchased in 4′ × 8′ or 4′ × 12′ sheets. Either of these sizes would build a 16′ long panel without waste. Panels could be 4′, 8′, 12′, or 16′ wide.)

2. Filler panel sizes determined by distance between pilasters minus the thickness of the sheathing on the pilaster form
3. Location of inside panels
   a. Tie holes in panel "a" must line up with tie holes in panel "b"
   b. Panel "a" will be ¾″ to the right of the left side of the pilaster

D. Determine panel sizes for other wall sections (See Figure 10.)

EXAMPLES:

1. Inside end wall will be made up of three panels: one main panel, and two fillers

   (NOTE: Two 16′ main panels can not be used because of tie spacing.)

2. Main panel will be located to line up with tie holes in outside panel "k" or "m"
3. Filler panel sizes will be 9′ – 0¾″ for panel "a" and 6′ – 11¼″ for panel "b"

   (NOTE: These two panels total 16′ and can be built without waste by using the salvage from the first panel to build the second.)

16′ – 0″
– 6′ – 11¼″
Panel a 9′ – 0 ¾″

16′ – 0″
– 9′ – 0¾″
Panel b 6′ – 11¼″

INFORMATION SHEET

4. Panel c will be 13′ – 8½″

$$\begin{array}{r}
15'-0'' \\
-\ 0'\ -11\tfrac{1}{4}'' \\
\hline
14'-\ 0\tfrac{3}{4}'' \\
-\qquad 4\tfrac{1}{4}'' \\
\hline
13'-\ 8\tfrac{1}{2}''
\end{array}$$

5. Panel will be 15′ – 7″

$$\begin{array}{r}
15'-11\tfrac{1}{4}'' \\
-\qquad 4\tfrac{1}{4}'' \\
\hline
15'-\ 7''
\end{array}$$

(NOTE: Panels "c" and "e" will be the same size as panels d and f.)

6. Panel g

   a. Stud frame, 15′ – 3½″

$$\begin{array}{r}
15'-0'' \\
+\qquad 4\tfrac{1}{4}'' \\
\hline
15'-4\tfrac{1}{4}'' \\
-\qquad \tfrac{3}{4}'' \\
\hline
15'-3\tfrac{1}{2}''
\end{array}$$

   b. Sheathing, 14′ – 11¼″

$$\begin{array}{r}
15'-\ 3\tfrac{1}{2}'' \\
-\qquad 4\tfrac{1}{4}'' \\
\hline
14'-11\tfrac{1}{4}''
\end{array}$$

   (NOTE: Panels g, h, i, and j will all be the same size. Make h and i left-hand panels and g and j right-hand panels.)

E. Determine size of pilaster panels

   EXAMPLES:

   1. Side panels will be 1′ – 0″

      (NOTE: This will be sheathing only.)

   2. Face panel will be 2′ – 8½″

$$\begin{array}{r}
2'-0'' \\
+\ 8\tfrac{1}{2}'' \\
\hline
2'-8\tfrac{1}{2}''
\end{array}
\qquad\qquad
\begin{array}{r}
4\tfrac{1}{4}'' \\
+4\tfrac{1}{4}'' \\
\hline
8\tfrac{1}{2}''
\end{array}$$

INFORMATION SHEET

F. Figure total quantity of panels needed to erect the foundation forms

EXAMPLE:

1. 18—16′-0″
2. 4—13′-10½″
3. 2—15′-3½″R
4. 2—15′-3½″L
5. 2—13′-8½″L
6. 2—15′-7″R
7. 2—9′-0¾″L
8. 2—6′-11¼″R
9. 8—2′-8½″
10. 16—1′-0″ sheathing only

WALL FORMS
UNIT IV

JOB SHEET #1 — CONSTRUCT STRAIGHT WALL WITH PATENTED FORMS

I. Tools and materials

A. Power handsaw and extension cord

B. Handsaw

C. Claw hammer

D. Sledge hammer

E. Folding rule or steel tape

F. Tape measure, 100 ft.

G. Carpenter's level

H. Builder's level and rod

I. Electric drill motor and drills

J. Chalk line

K. Plumb bob

L. Framing square

M. Adjustable wrench, 16"

N. All special tools supplied by the form manufacturer

O. Powder-actuated fastener and pins

P. Patented forms and accessories (10–4′×8′ panels, 4–4″ corners)

(NOTE: No two companies make the same type of form ties, panel clamps, aligner clamps, or panels. When a particular type is selected, that system must be referred to for all accessories and installation instructions.)

Q. 2×4's or 2×6's for plates, braces, and strongbacks

R. Stakes

S. 1×2's for grade strips

T. Nails, 8d and 16d duplex

JOB SHEET #1

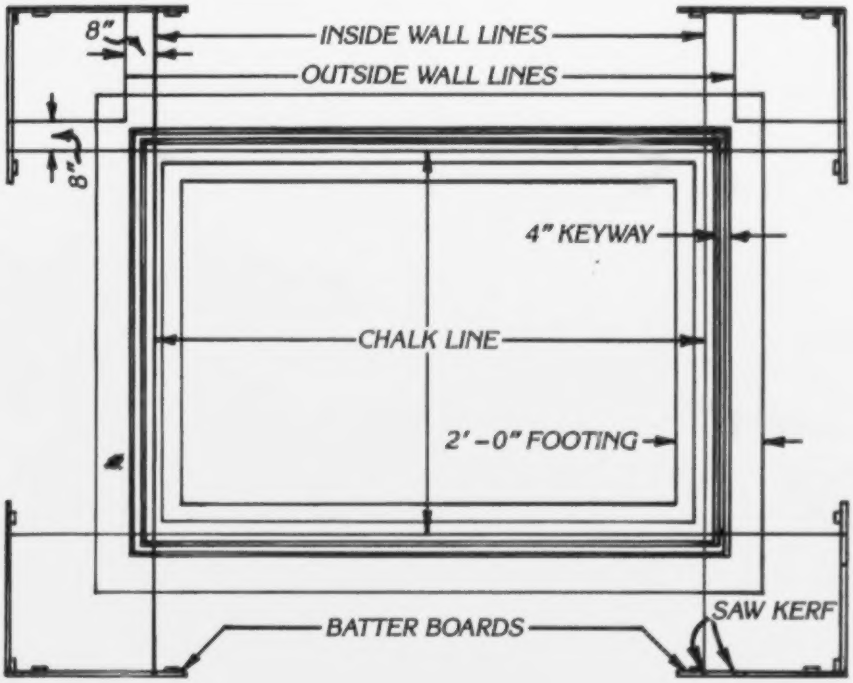
II. Procedure

A. Use plumb bob to transfer the building lines to the footing

B. Snap chalk lines for the outside forms on the footing (Figure 11)

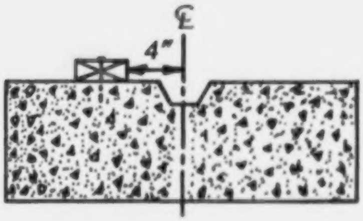
(NOTE: Wall lines may be scored on the footings.)

FIGURE 11


8"
INSIDE WALL LINES
OUTSIDE WALL LINES
8"
4" KEYWAY
CHALK LINE
2'-0" FOOTING
BATTER BOARDS
SAW KERF

C. Secure 2×4 plates to the footing using powder-actuated fastener (Figure 12)

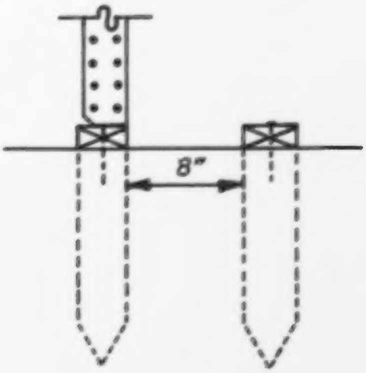
FIGURE 12



(NOTE: If erecting without footing, drive stakes to support the plates as shown in Figure 13.)

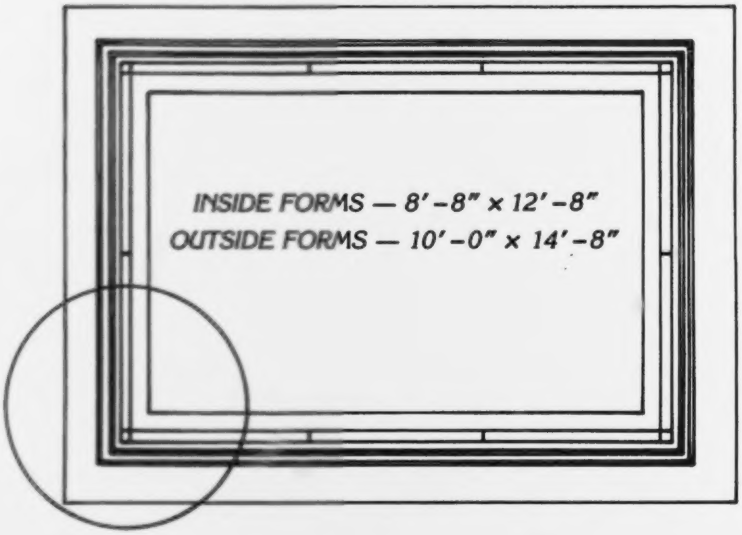
JOB SHEET #1

FIGURE 13



D. Layout location of panels starting in a corner (Figure 14a & 14b)

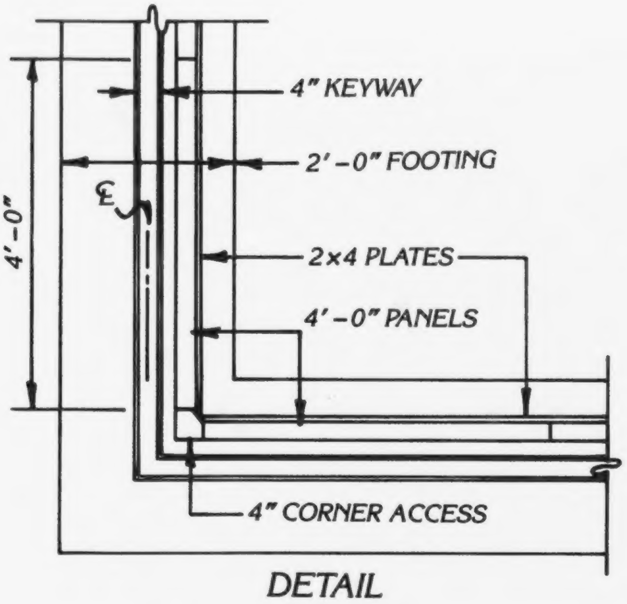
FIGURE 14a


INSIDE FORMS — 8'-8" x 12'-8"
OUTSIDE FORMS — 10'-0" x 14'-8"

(NOTE: Panels must be directly opposite each other. Figure 14b shows an inside corner accessory. There are many other accessories used by patent form manufacturers. Consult the manufacturer for specific accessories prior to setting forms.)

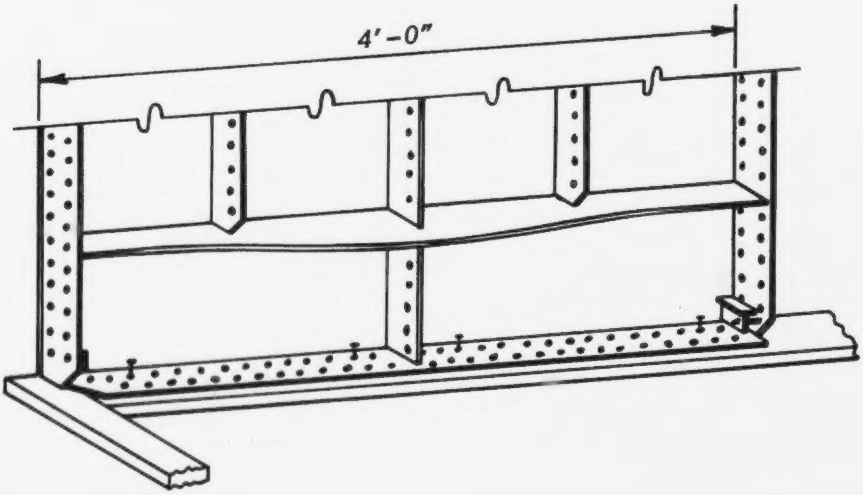
JOB SHEET #1

FIGURE 14b


4" KEYWAY
2'-0" FOOTING
℄
2×4 PLATES
4'-0" PANELS
4'-0"
4" CORNER ACCESS
DETAIL

E. Secure outside form panel to the base plate using nail holes provided (Figure 15)

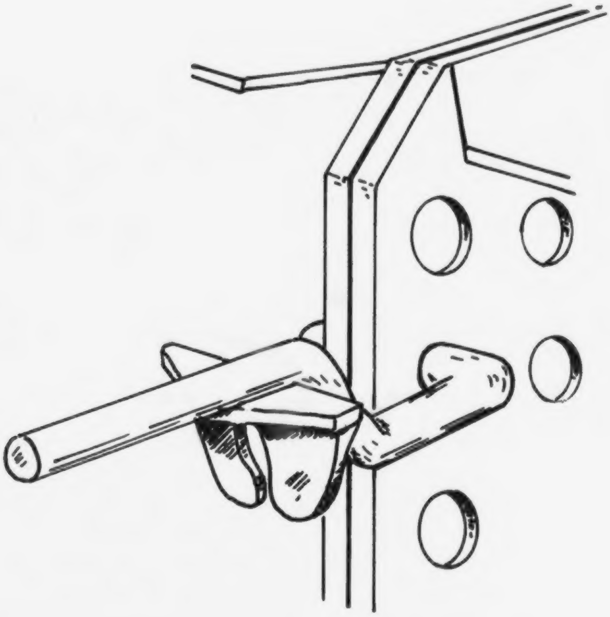
FIGURE 15



JOB SHEET #1

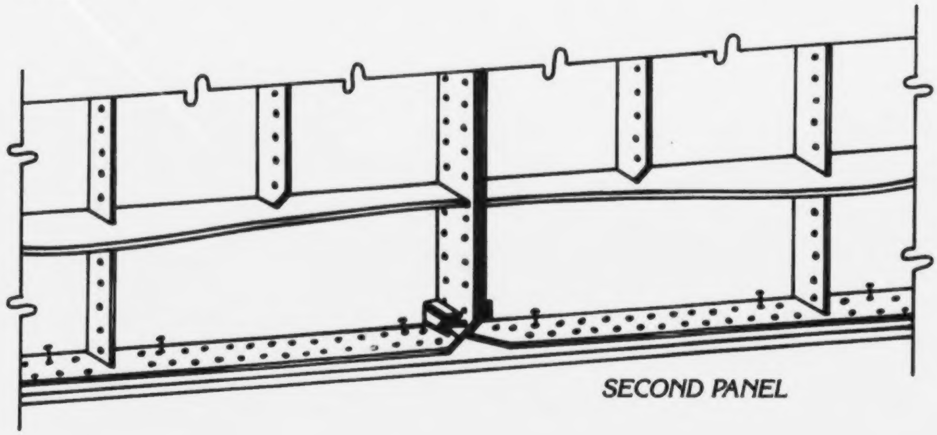
F. Set the adjacent form panel in place and install clamp (Figure 16)

FIGURE 16



G. Push the panel into alignment with the base plate and nail (Figure 17)

FIGURE 17



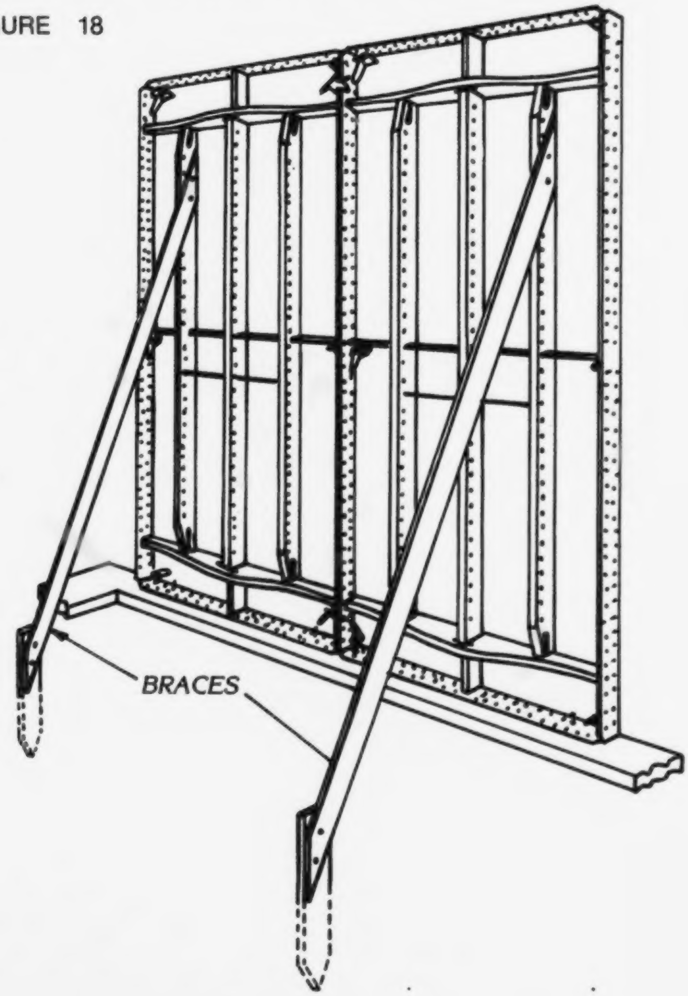
JOB SHEET #1

H. Repeat steps F and G to continue erecting the remaining panels for the outside form.

(NOTE: Leave out one panel for access.)

I. As forms are erected install temporary braces (Figure 18)

FIGURE 18



J. Install aligners (strongbacks) if used

K. Install braces and align top of form

(NOTE: This alignment can be done by plumbing the panels and sighting along the top edge.)

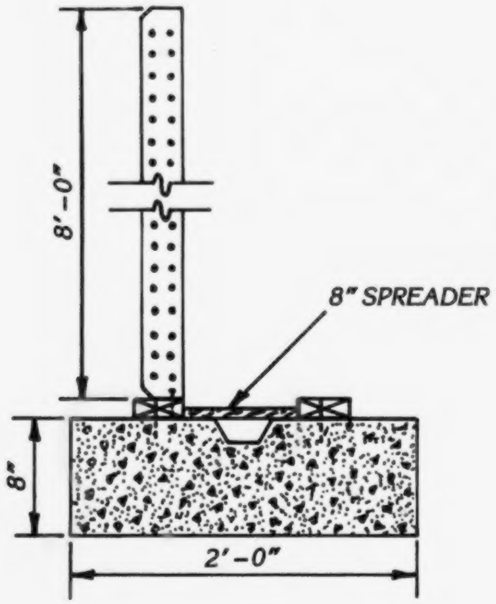
JOB SHEET #1

L. Build and install all sleeve pockets, offsets, or blockouts needed in the finished wall

(NOTE: Exercise care to avoid cutting and drilling unnecessary holes. Also, form oil must be applied and rebars installed before inside form can be set.)

M. Set plates for inside panels (Figure 19)

FIGURE 19



N. Install form ties

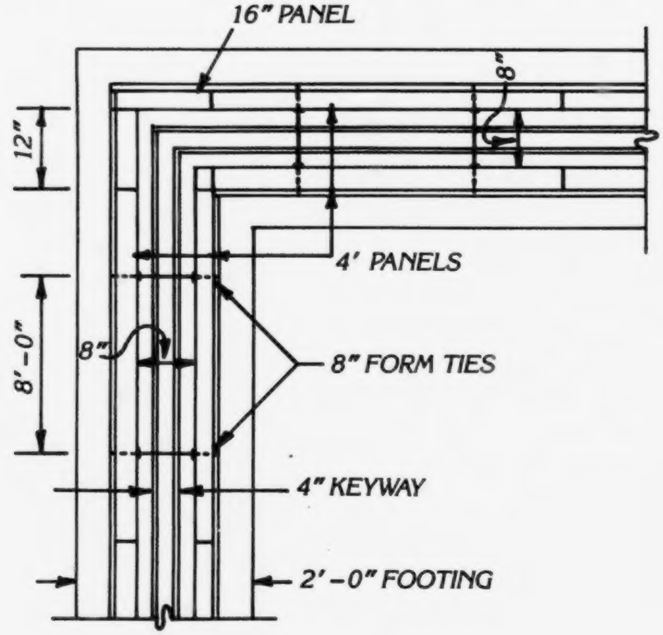
(NOTE: With some form systems the ties must be installed when erecting the first side of the form.)

O. Erect second side of form following the same procedures outlined in steps E through I (See Figure 20.)

(NOTE: Erection can start anywhere along the wall but the main panels must be erected directly opposite each other.)

JOB SHEET #1

FIGURE 20


16" PANEL
12"
8"
4' PANELS
8'-0"
8"
8" FORM TIES
4" KEYWAY
2'-0" FOOTING

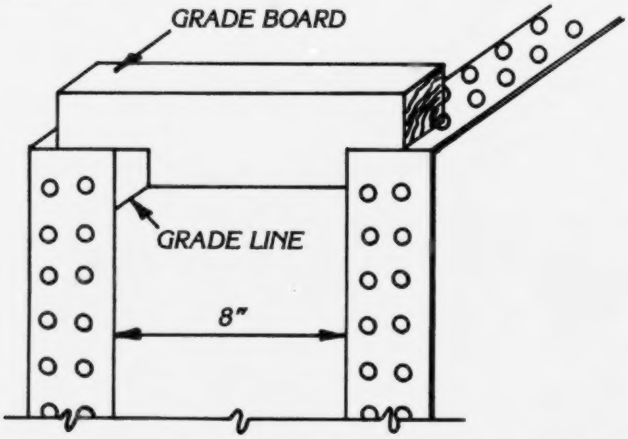
P. Establish the concrete grade on the forms

(NOTE: Quite often the forms can be set where the top of the form is on grade, but at times this is not possible. When grade must be established inside the form there are various methods to choose from.)

1. Grade board method (Figure 21)

   (NOTE: This method may be used if most of the panels are the same height and level on top.)

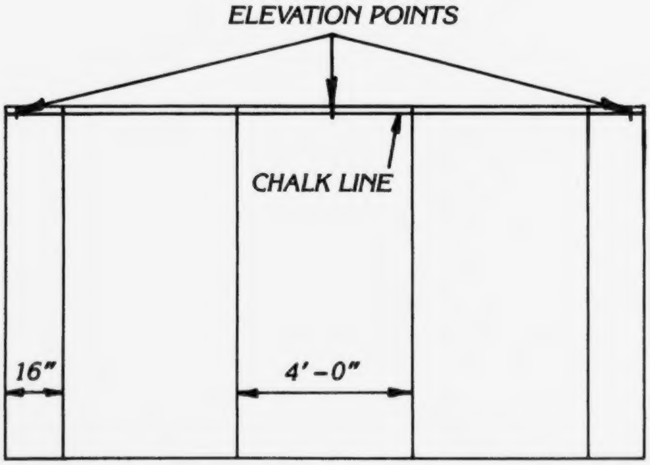
FIGURE 21


GRADE BOARD
GRADE LINE
8"

JOB SHEET #1

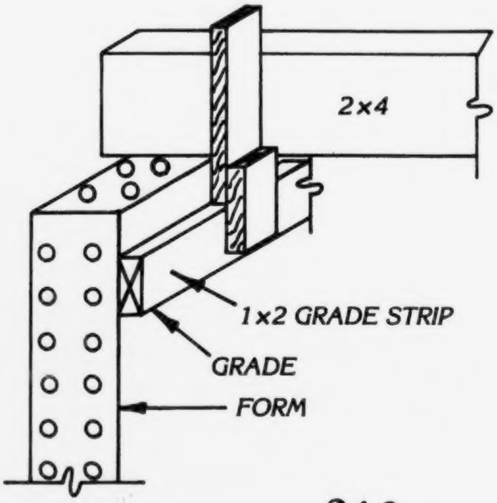
2. Grade strip method
   a. Measure from top of form or establish elevation points with builder's level
   b. Snap a chalk line from one established elevation point to another to mark the grade (Figure 22)

FIGURE 22


ELEVATION POINTS
CHALK LINE
16"
4'-0"

   c. Attach grade strip by fastening to a hanger that is nailed across top of form (Figure 23)

FIGURE 23

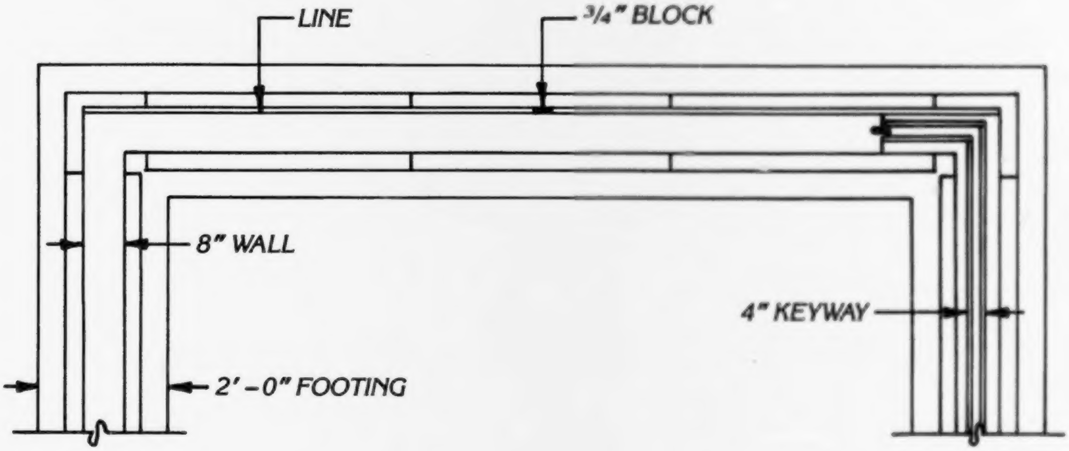

2×4
1×2 GRADE STRIP
GRADE
FORM

JOB SHEET #1

(NOTE: Nail grade strip to panel if wood sheathing is used on the form system. Sometimes grade nails are set along the chalk line and used as a grade.)

Q. Recheck form alignment (Figure 24)

FIGURE 24



1. Adjust forms so that both ends are set to their established line

2. Secure line to top of forms at both ends 3/4" out from face of form and draw taut

3. Use a 3/4" gauge block to check alignment at intermediate points

4. Adjust braces to secure form alignment

WALL FORMS
UNIT IV

JOB SHEET #2 — CONSTRUCT GANG FORMS FOR A BATTERED WALL

I. Tools and equipment

  A. Power handsaw and extension cord

  B. Handsaw

  C. Claw hammer

  D. Sledge hammer

  E. Tape measure, 100 foot.

  F. Folding rule or steel tape

  G. Hand level

  H. Builder's level

  I. Electric drill motor and drills

  J. Chalk line

  K. Powder-actuated fastener and pins

  L. Plumb bob

  M. Framing square

  N. Wrench, adjustable, 16"

  O. Stakes

  P. 2×4's or 2×6's for plates and braces

  Q. Panels

  R. Form ties, washers and nuts

  S. Walers

  T. Waler support brackets

  U. Duplex nails

  V. Wire

JOB SHEET #2

II. Procedure

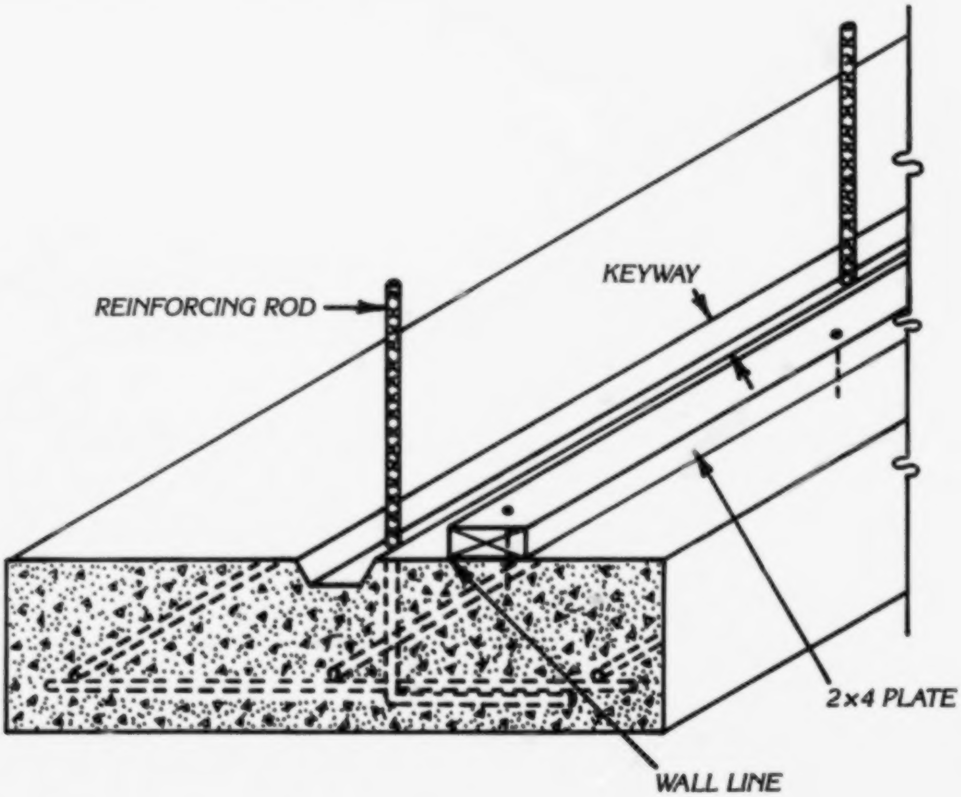
A. Locate wall line on footings

B. Snap a chalk line on the footing at the plumb side of the wall

C. Nail sole plates to footings

(NOTE: Use 2 ½" concrete nails or powder-actuated fastener with 2 ½" pins. See Figure 25.)

FIGURE 25

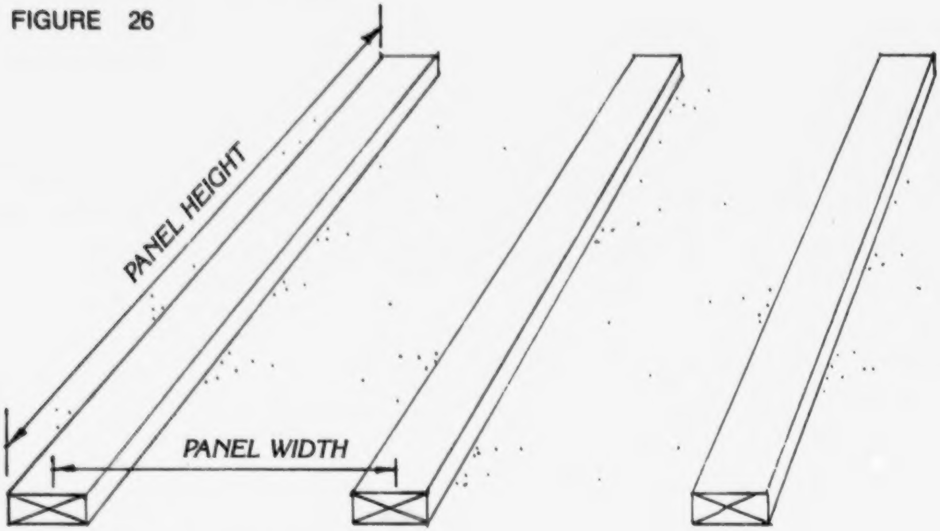

KEYWAY
REINFORCING ROD
2×4 PLATE
WALL LINE

JOB SHEET #2

D. Build gang form

1. Level stringers of 2-inch or thicker material long enough to accommodate gang form (Figure 26)

FIGURE 26

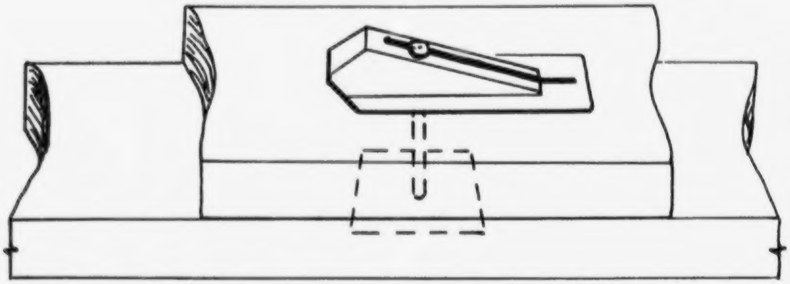


2. Lay panels face down on bed

   (NOTE: The bed may be on the ground or on sawhorses.)

3. Bolt panels together with machine bolts or panel lock bolts (Figure 27)

FIGURE 27



PANEL LOCK BOLT

JOB SHEET #2

4. Attach waler support brackets (Figures 28a, 28b, and 28c)

   (NOTE: Supports 28b and 28c are nailed to the stud; 28a requires a drilled hole in the stud.)

FIGURE 28a

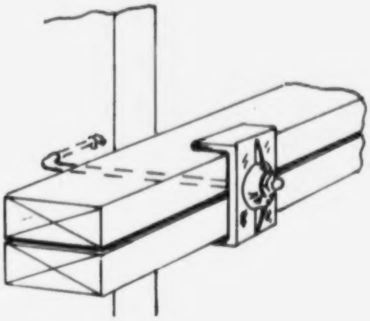


FIGURE 28b

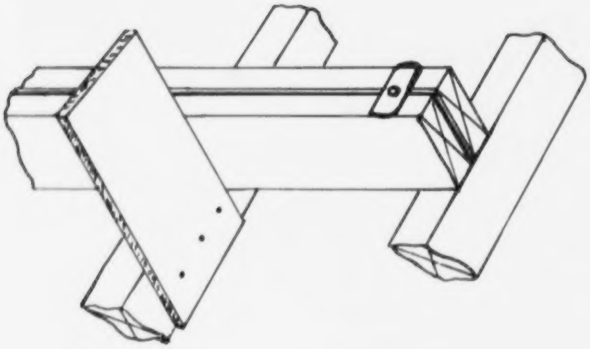
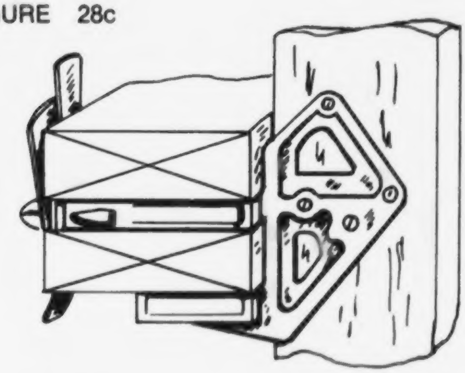


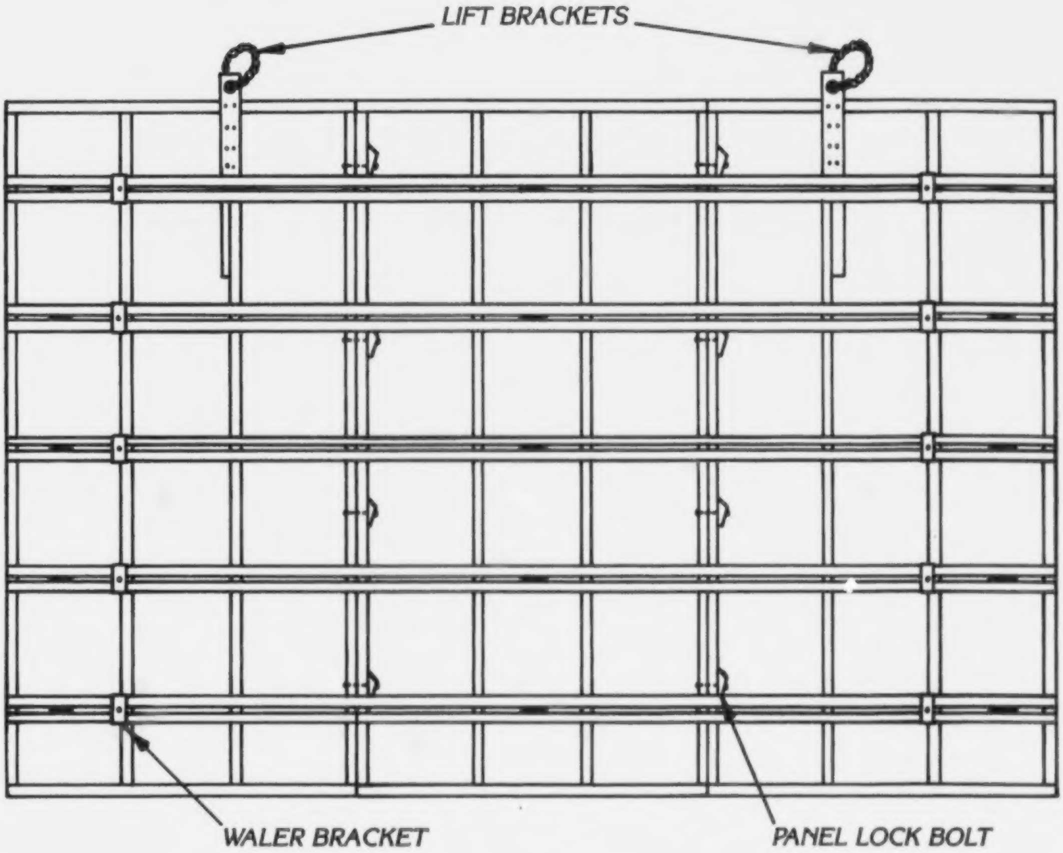
FIGURE 28c



JOB SHEET #2

5. Install walers (Figure 29)

FIGURE 29



6. Install lifting brackets as shown in Figure 29

   (NOTE: Position of lifting brackets is determined by length of panel. For long panels, two are recommended.)

7. Build all panels needed for job

   (NOTE: Several factors are used to determine the number of panels needed. They are length of pour, length of wall, erection time, and the length of time form must remain on wall after it is poured.)

JOB SHEET #2

8. Lift panel off bed

   (NOTE: A crane or boom truck may be used. Panels may be stored or set as their building progresses.)

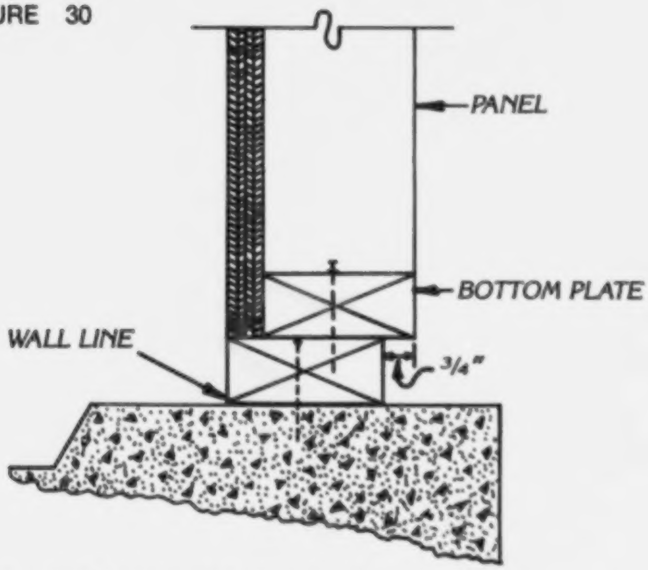
   CAUTION

   All safety precautions should be exercised when lifting panels. Use tag line and all other precautions.

E. Erect first side of form (plumb side)

1. Place first panel on sole plate
2. Align face of form with wall line (Figure 30)

FIGURE 30

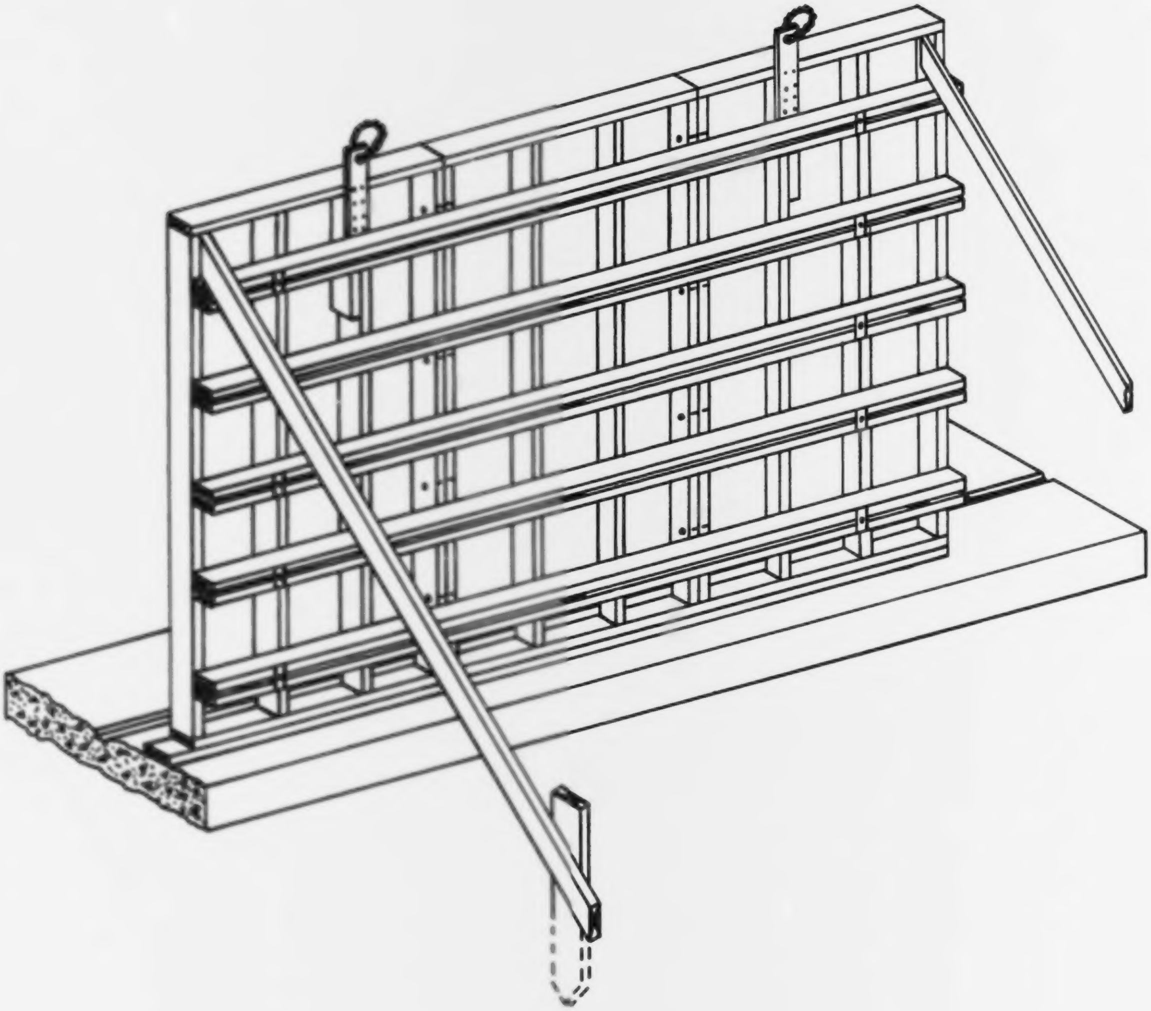


3. Nail bottom plate to sole plate
4. Brace and plumb panel at both ends (See Figure 31.)

   (NOTE: Do not cover panel bolt holes.)

JOB SHEET #2

FIGURE 31



5. Set adjacent gang form
6. Bolt to first gang form

   (NOTE: Use panel lock bolts as shown in Figure 27.)
7. Align face with wall line and nail to sole plate
8. Plumb and brace free end

JOB SHEET #2

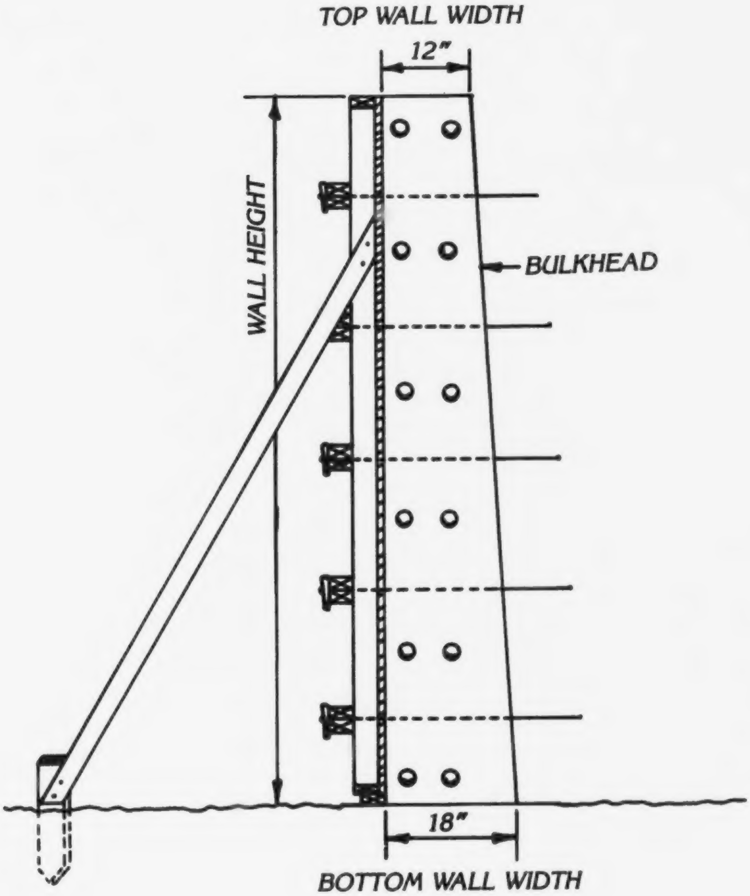
9. Repeat steps 5 through 8 to continue erection

10. Install wall ties

F. Build and install bulkheads

1. Build bulkhead to height and shape of wall (Figure 32)

FIGURE 32

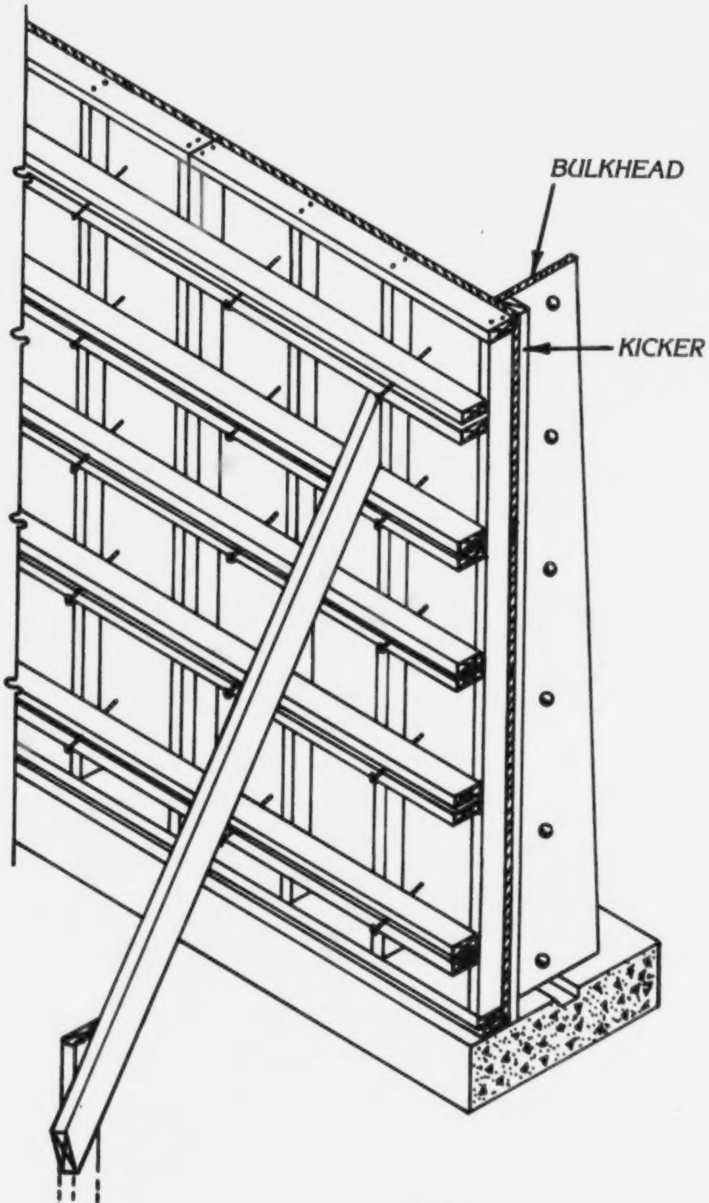

TOP WALL WIDTH
12"
WALL HEIGHT
BULKHEAD
18"
BOTTOM WALL WIDTH

JOB SHEET #2

2. Nail kicker to form at bulkhead location on both ends of form and install bulkhead (Figure 33 and 34)

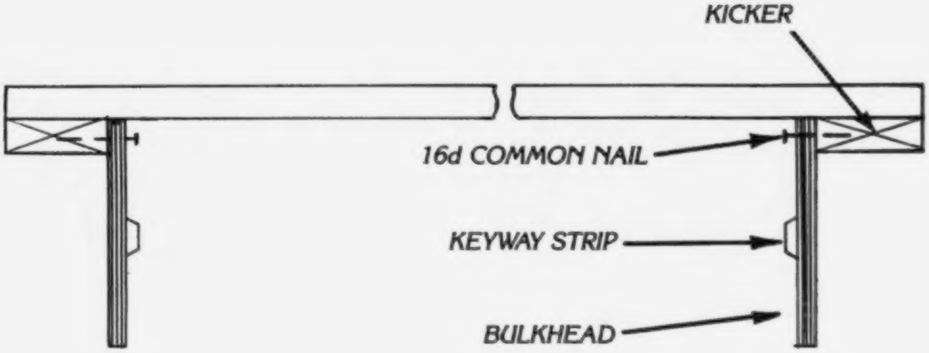
   (NOTE: Form oil must be applied before rebars are installed. All rebars should be completely installed before second form is placed.)

FIGURE 33



JOB SHEET #2

FIGURE 34

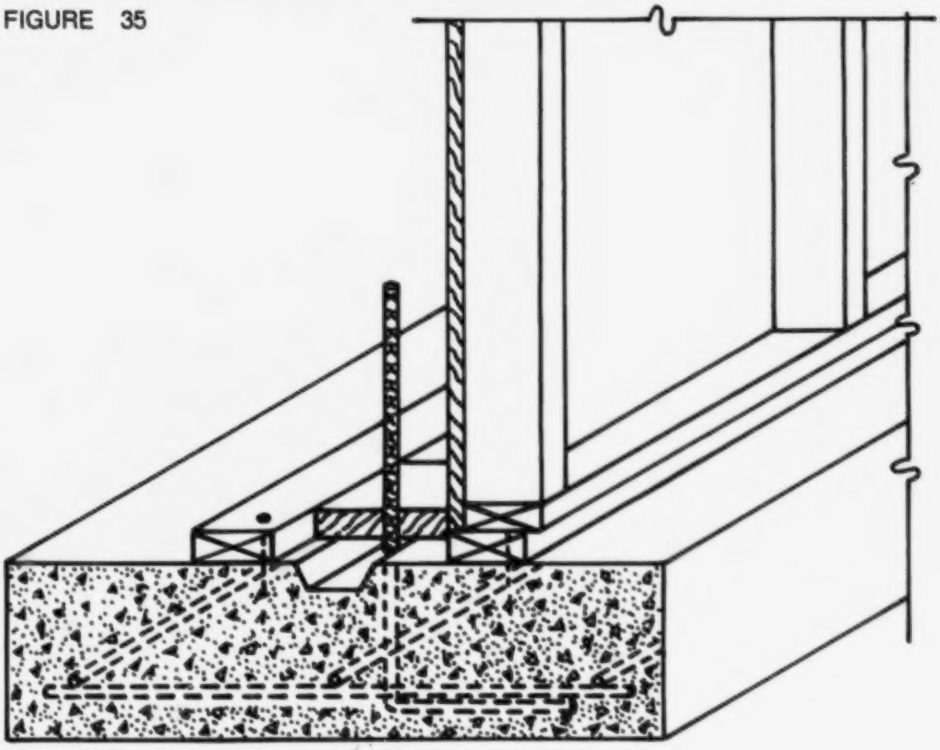

KICKER
16d COMMON NAIL
KEYWAY STRIP
BULKHEAD

G. Set second side of forms

1. Set sole plate (Figure 35)

   (NOTE: Use spreader and secure plate just as opposite plate was secured.)

FIGURE 35



JOB SHEET #2

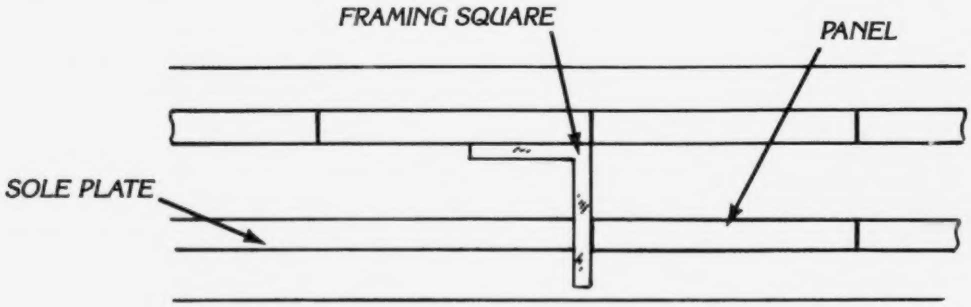
2. Nail bulkhead kicker on first gang form to correspond with opposite sides

   (NOTE: Spreader should be removed after plate is set.)

3. Stand first gang form on sole plate (Figure 36)

   (NOTE: Position form squarely across from opposite form. Tack spreaders to form.)

FIGURE 36



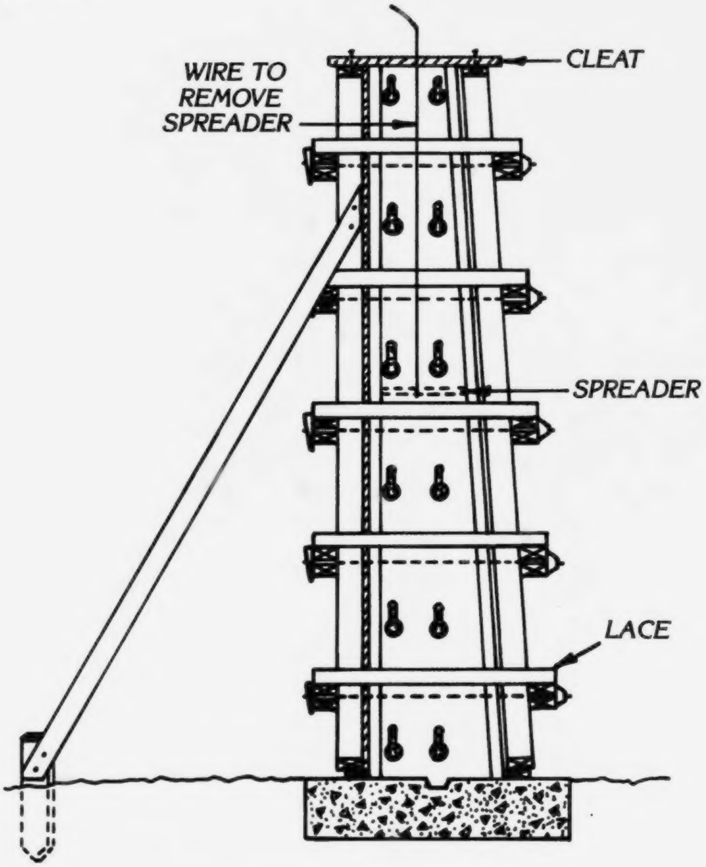
4. Place on wall line and nail to soleplate

5. Nail a cleat across both ends of the form to hold it in place (See Figure 37.)

   (NOTE: Maintain correct wall thickness at lead end. The back end is against bulkhead. Braces may not be needed on this side.)

JOB SHEET #2

FIGURE 37


WIRE TO REMOVE SPREADER
CLEAT
SPREADER
LACE

(NOTE: Spreader can be removed by driving one end down. This will release the pressure, then it can be pulled out with the wire.)

6. Set adjacent gang form
7. Bolt to first gang form

   (NOTE: Use panel lock bolts as shown in Figure 27.)

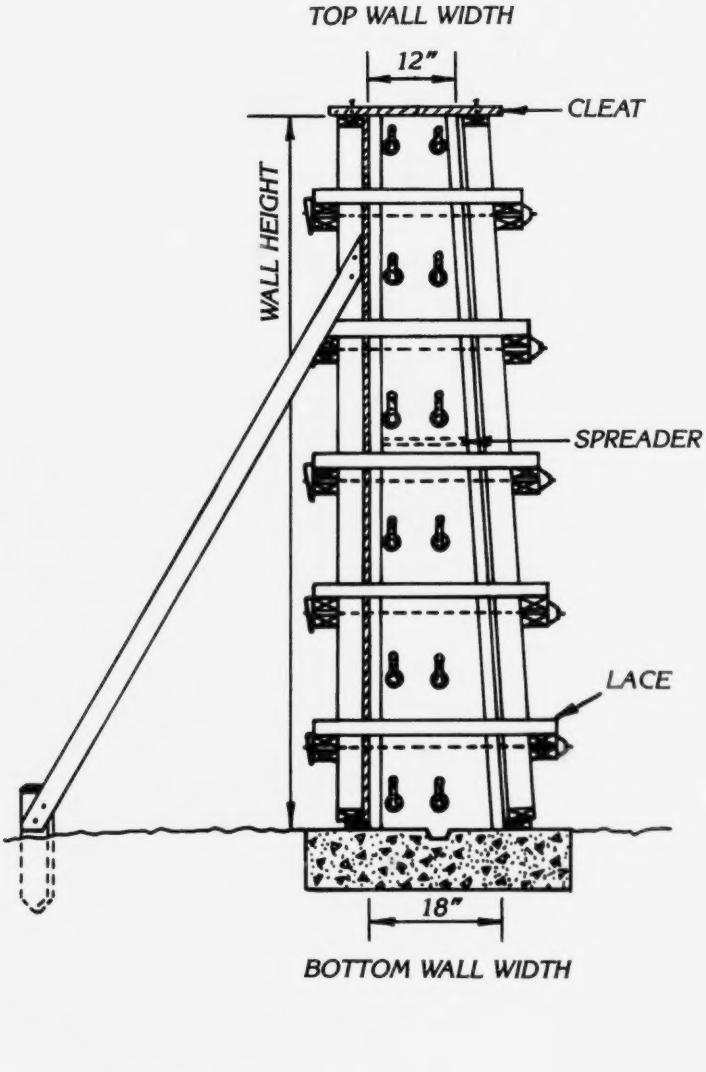
8. Nail cleat across top of form at free end as shown in Figure 37

JOB SHEET #2

9. Repeat steps 5, 6, and 7 to continue erection

   (NOTE: Ties should be tightened snugly, but avoid pulling spreaders into sheathing by tightening too much. Vertical end rows at bulkhead can be drawn tightly. This will help hold the bulkhead. (See Figure 38.)

FIGURE 38

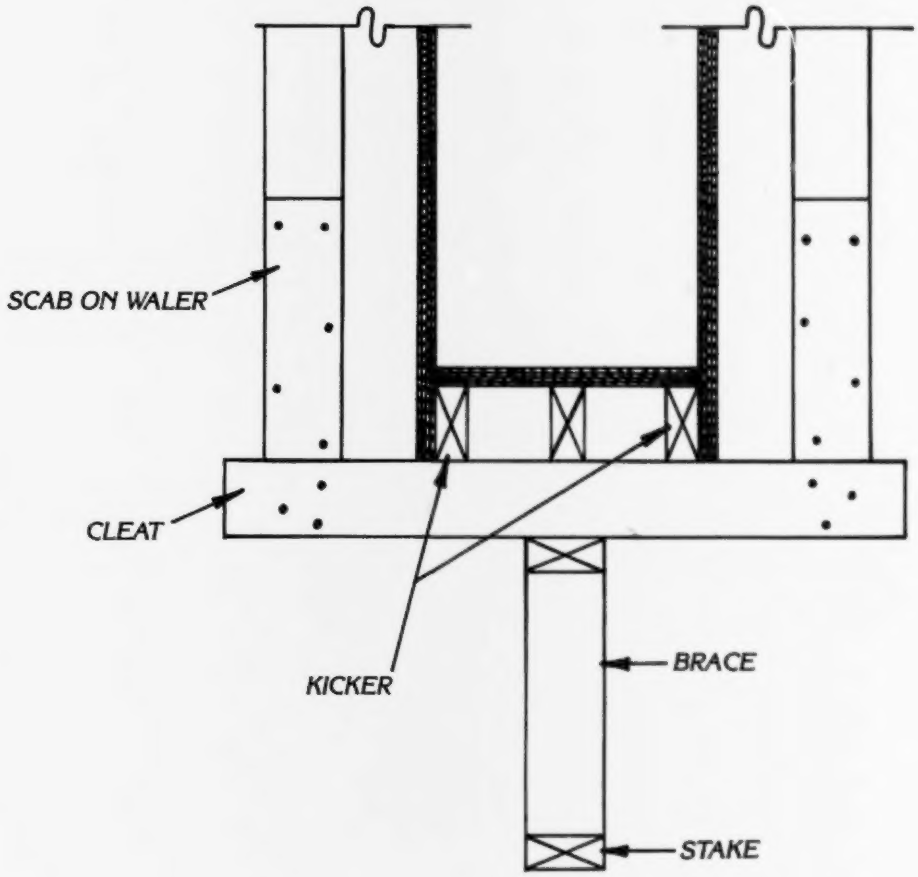

TOP WALL WIDTH
12"
CLEAT
WALL HEIGHT
SPREADER
LACE
18"
BOTTOM WALL WIDTH

JOB SHEET #2

I. Install additional support for bulkhead (if needed) (Figure 39.)

(NOTE: The pressure on the bulkhead is the same as on the form.)

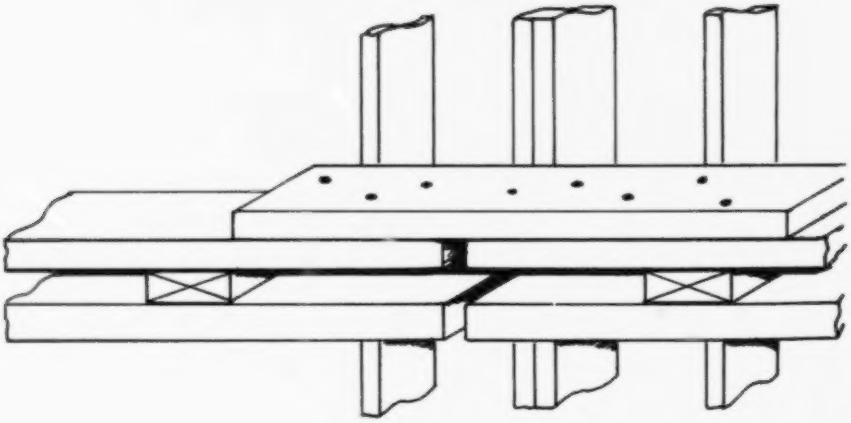
FIGURE 39


SCAB ON WALER
CLEAT
KICKER
BRACE
STAKE

JOB SHEET #2

J. Nail scabs over all waler joints (Figure 40)

FIGURE 40



WALL FORMS
UNIT IV

JOB SHEET #3 — CONSTRUCT CIRCULAR WALL FORMS (BUILT-IN-PLACE)

I. Tools and materials

  A. Power handsaw and extension cord
  B. Handsaw
  C. Claw hammer
  D. Sledge hammer
  E. Steel tape measure, 100 foot
  F. Folding rule or steel tape
  G. Hand level
  H. Builder's level
  I. Electric drill motor and drills
  J. Chalk line
  K. Powder-actuated fastener and pins
  L. Plumb bob
  M. Framing square
  N. String line
  O. Stakes
  P. Sheathing
  Q. Spreaders
  R. Form ties and clamps
  S. 2×4's or 2×6's for braces and studs
  T. Nails
    1. 8d duplex
    2. 16d duplex

JOB SHEET #3

   3. 6d common

   4. 16d common

   5. 8d common

U. 2×12 for segmental template ring

V. 1×4's

II. Procedure

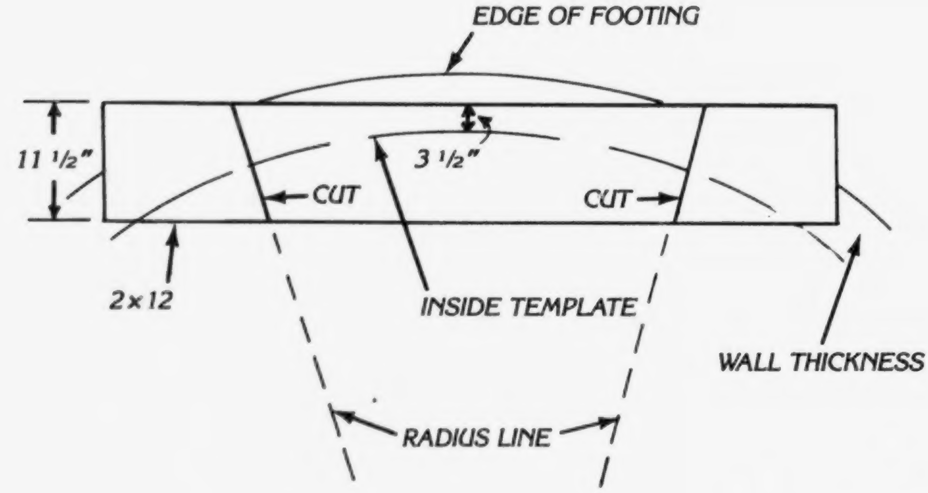
A. Determine height of wall and radius from plan

B. Measure radius from center point to lay out circumference of wall

(NOTE: Lay out both inside and outside wall lines.)

C. Lay out segmental template (Figure 41)

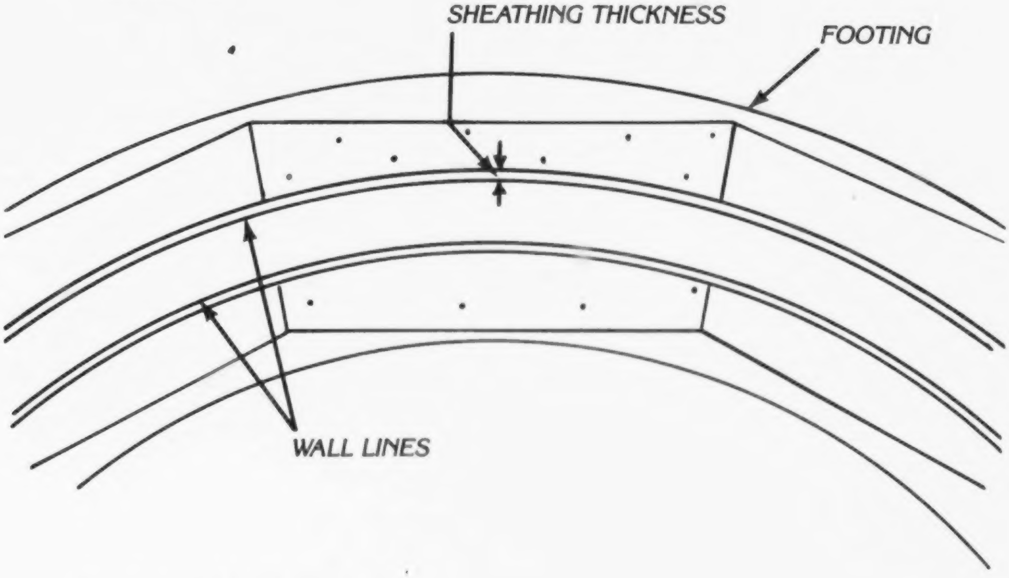
FIGURE 41


EDGE OF FOOTING
11 1/2"
3 1/2"
CUT
CUT
2×12
INSIDE TEMPLATE
WALL THICKNESS
RADIUS LINE

JOB SHEET #3

D. Secure base templates to footing (Figure 42)

FIGURE 42

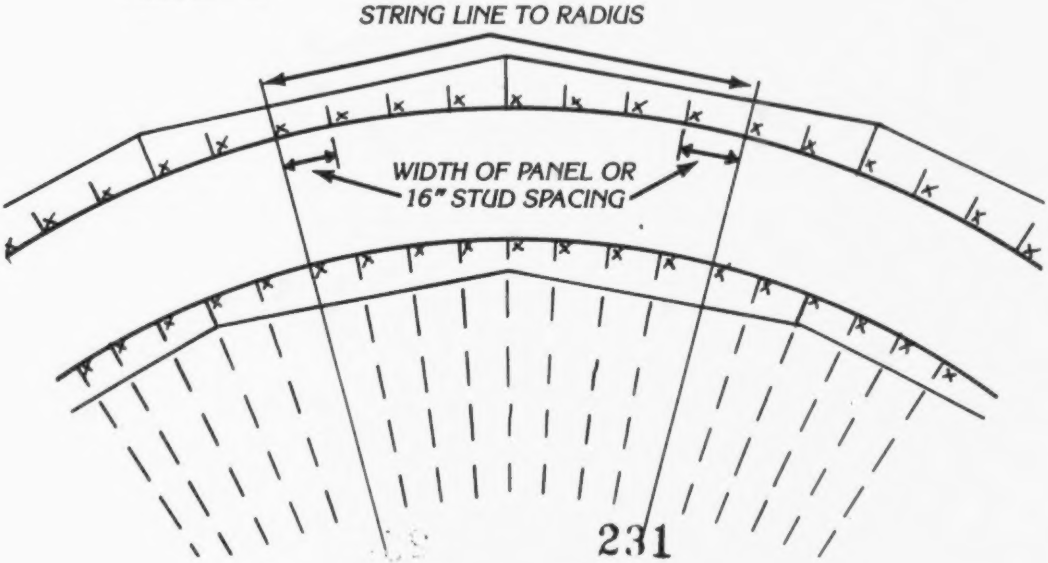

SHEATHING THICKNESS
FOOTING
WALL LINES

E. Cut studs to length

F. Lay out stud spacing on both templates (Figure 43)

(NOTE: Set inside form first.)

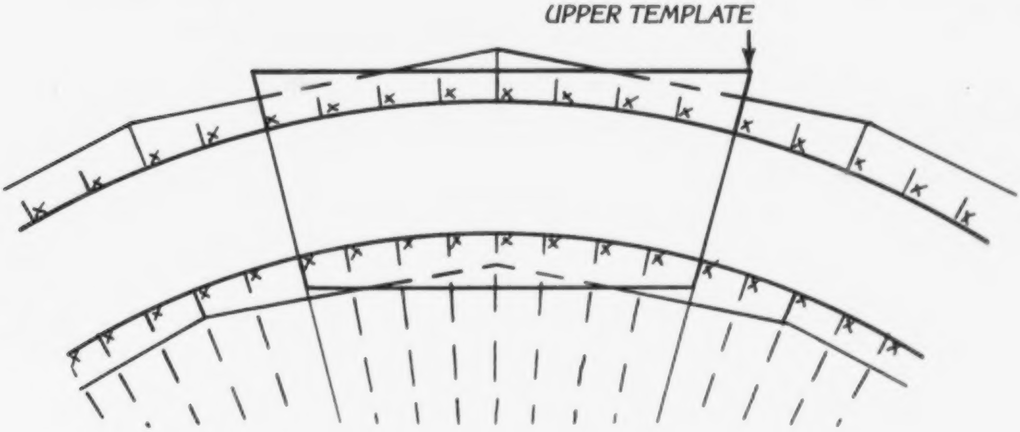
FIGURE 43


STRING LINE TO RADIUS
WIDTH OF PANEL OR
16" STUD SPACING

JOB SHEET #3

G. Tack upper segmental templates to base plate and transfer stud layout (Figure 44)

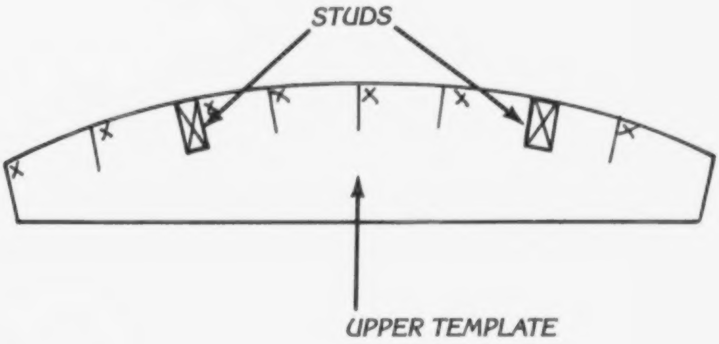
FIGURE 44


UPPER TEMPLATE

H. Nail two studs to an upper segment of template (Figure 45)

(NOTE: Stagger segment joints.)

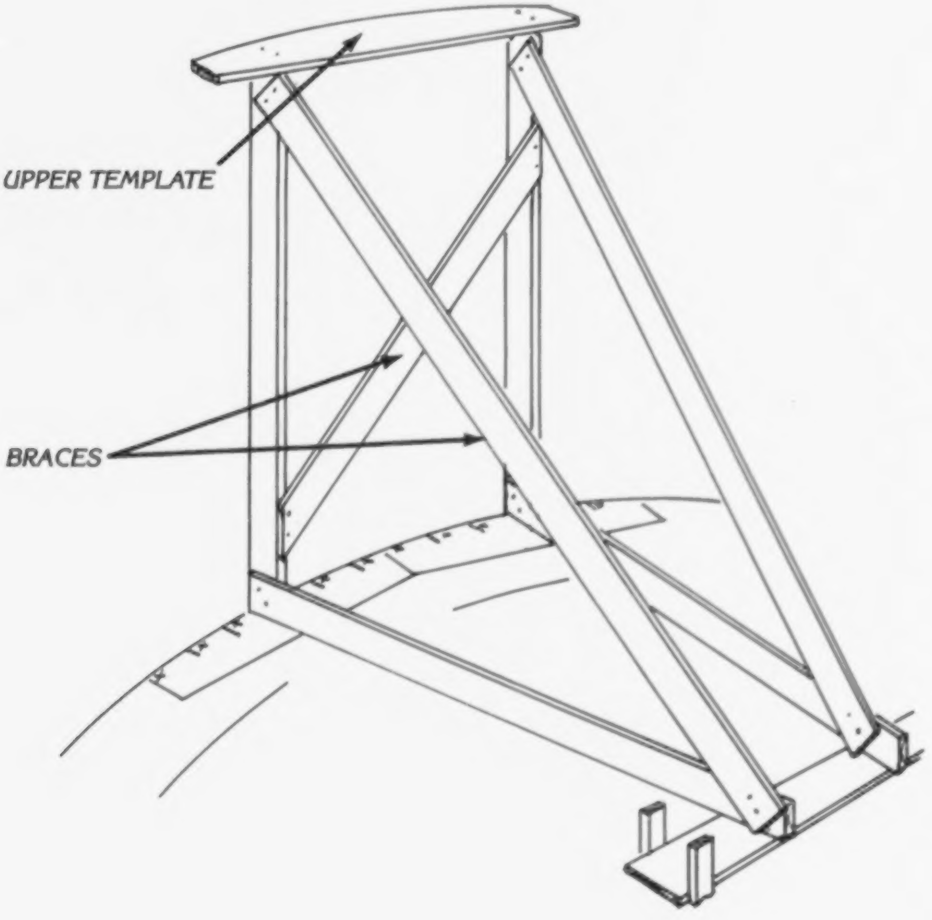
FIGURE 45


STUDS
UPPER TEMPLATE

JOB SHEET #3

I. Stand unit in position; plumb and brace (Figure 46)

FIGURE 46



J. Nail intermediate studs to upper and lower templates

K. Continue erection as outlined in steps H, I, and J

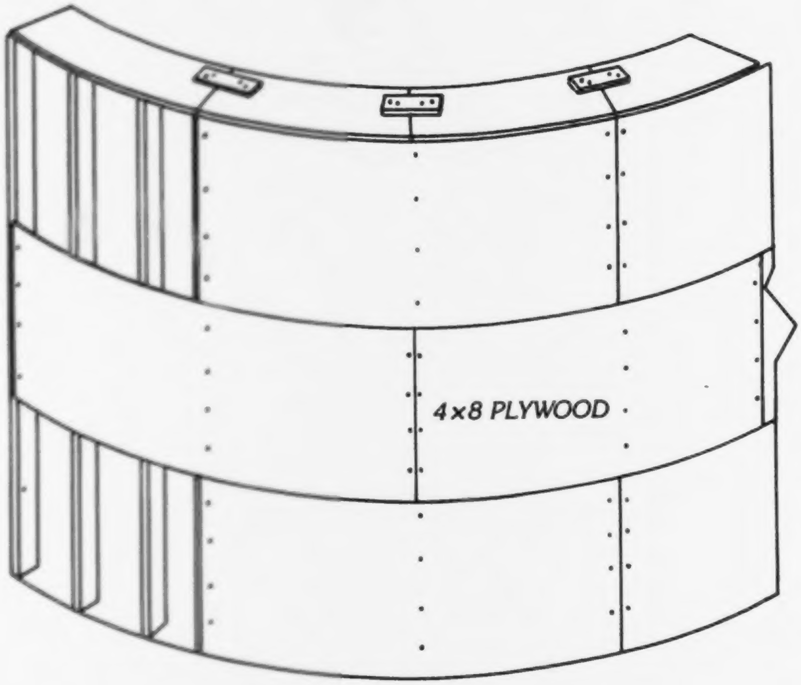
L. Nail scabs across joints of upper template

(NOTE: This may be done as erection progresses around the circle.)

JOB SHEET #3

M. Nail on sheathing (Figure 47)

FIGURE 47

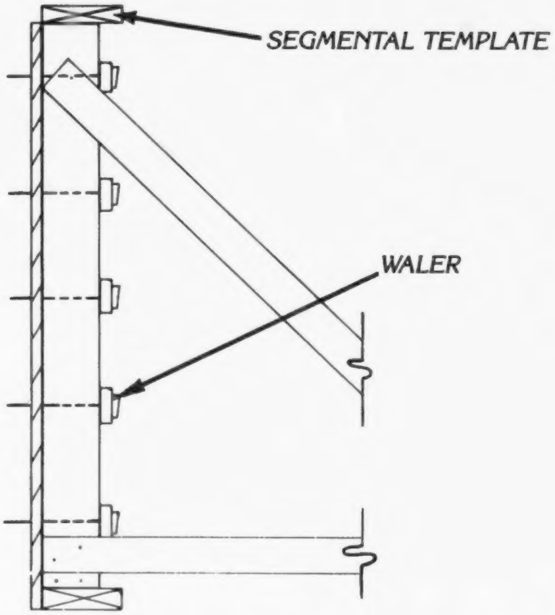


N. Install inside walers (Figure 48)

(NOTE: Use the thickest material that springs to the circumference for walers. A double thickness of one-inch material may be used.)

JOB SHEET #3

FIGURE 48



O. Drill holes for form ties

(NOTE: Place ties as close to studs as possible.)

P. Build and install all pockets, sleeves, or other blockouts needed in the finished wall

(NOTE: Reinforcing bars, if called for, should be installed at this time.)

Q. Place form ties through inside wall and waler; secure with tie clamp

R. Sheath and stud outside form

(NOTE: Prebuilt panels may be used for outside forms. Narrow vertical panels work best. The width of the panels should be in direct relationship to the stud spacing.)

1. Attach studs to each panel
2. Drill tie holes

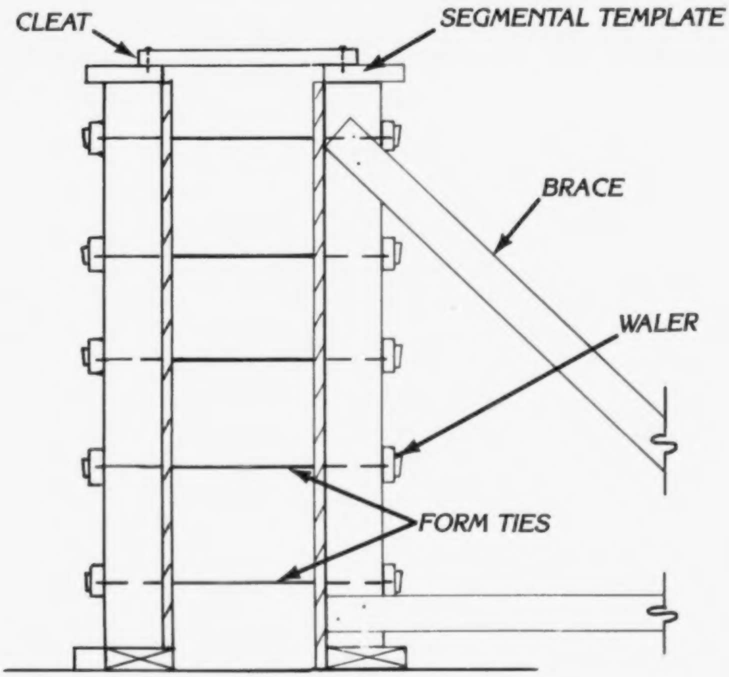
   (NOTE: Make sure tie holes line up with inside form on radius line.)
3. Stand panel up and thread in ties

JOB SHEET #3

4. Nail upper template to studs
5. Nail cleat across the top to hold panels vertically (See Figure 49.)

   (NOTE: After a number of panels have been erected, waler may be installed and tie clamps secured to ties.)

FIGURE 49


CLEAT
SEGMENTAL TEMPLATE
BRACE
WALER
FORM TIES

S. Continue erection as outlined in steps 1 through 5 above

WALL FORMS
UNIT IV

JOB SHEET #4 — CONSTRUCT PANEL FORMS

I. Tools and materials

- A. Power handsaw and extension cord
- B. Handsaw
- C. Claw hammer
- D. Sledge hammer
- E. Tape measure, 100 foot
- F. Folding rule or steel tape
- G. Hand level
- H. Builder's level
- I. Electric drill motor and drills
- J. Chalk line
- K. Powder-actuated fastener and pins
- L. String line
- M. Plumb bob
- N. Framing square
- O. Stakes
- P. 2×4's or 2×6's for studs and plate
- Q. Plyform sheathing
- R. Plank, 2×10 (for jig table)
- S. Form ties and clamps for walls and pilasters
- T. Lag bolts
- U. Nails
    - 1. 16d duplex
    - 2. 6d cement-coated
- V. Form oil

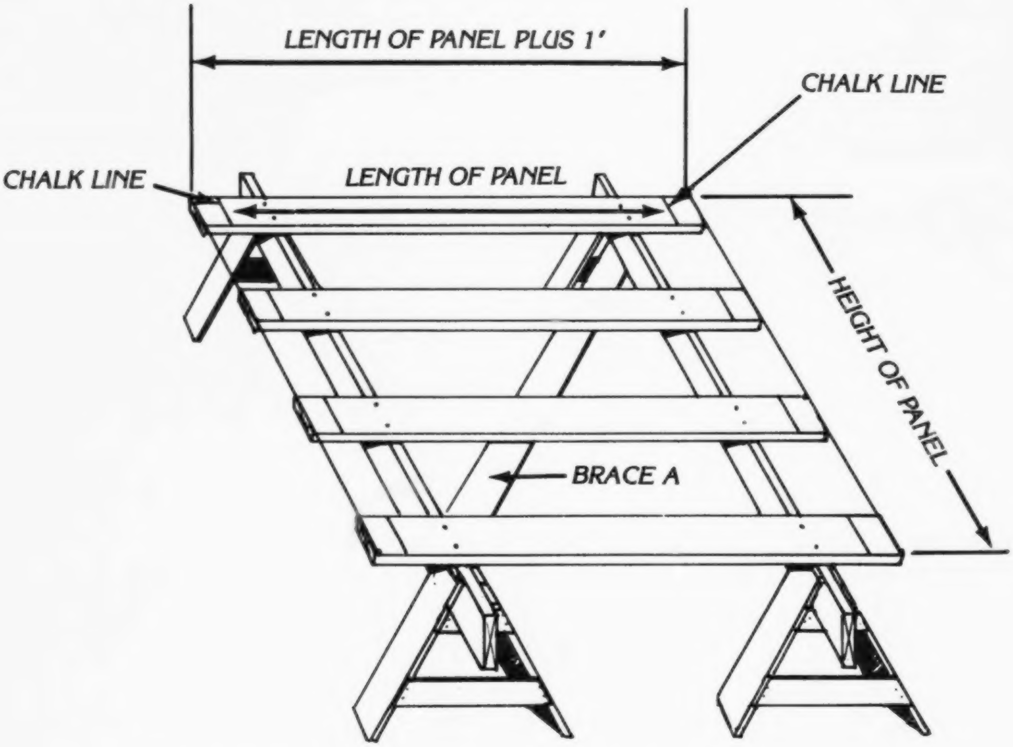
JOB SHEET #4

II. Procedure

A. Determine height, width, and quantity of panels needed

B. Build a jig table (Figure 50)

FIGURE 50


LENGTH OF PANEL PLUS 1'
CHALK LINE
CHALK LINE
LENGTH OF PANEL
HEIGHT OF PANEL
BRACE A

1. Secure or build horses at a convenient work height (usually two feet)
2. Lay plank across the horses and nail

   (NOTE: The platform should be a little larger than the panel.)
3. Check for square and nail brace A

JOB SHEET #4

4. Lay out stud spacing on both outside planks (Figure 51)

FIGURE 51

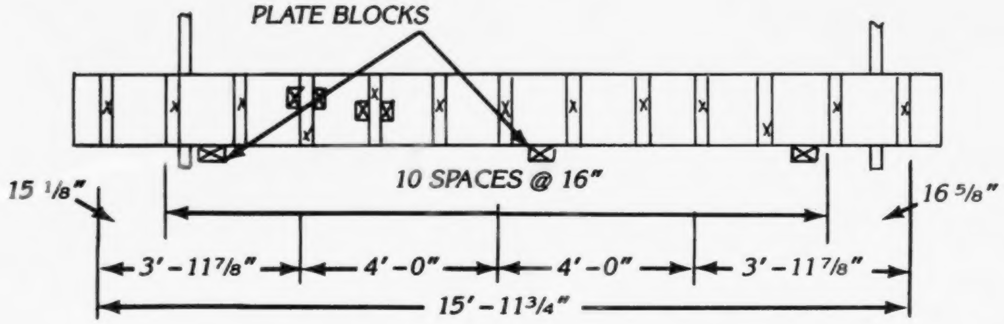
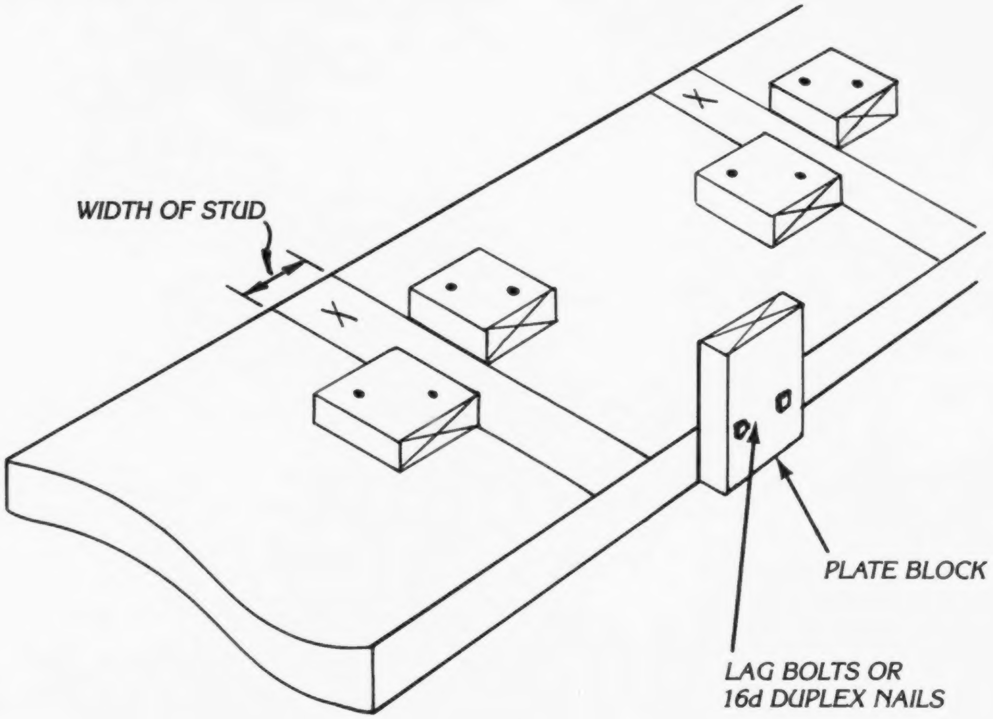


PLATE BLOCKS
10 SPACES @ 16"
15 1/8"
16 5/8"
3'-11 7/8"
4'-0"
4'-0"
3'-11 7/8"
15'-11 3/4"

5. Nail jig blocks to platform, one on each side of stud layout (Figure 52)

FIGURE 52


WIDTH OF STUD
PLATE BLOCK
LAG BOLTS OR
16d DUPLEX NAILS

JOB SHEET #4

6. Nail or bolt plate blocks on one edge of plank

   (NOTE: The jig is now ready to use.)

C. Build panels

1. Cut plates and studs to correct length

   (NOTE: Accuracy is very important in all phases of panel building.)

2. Make template for panel lock bolt holes (Figures 53 and 54)

FIGURE 53

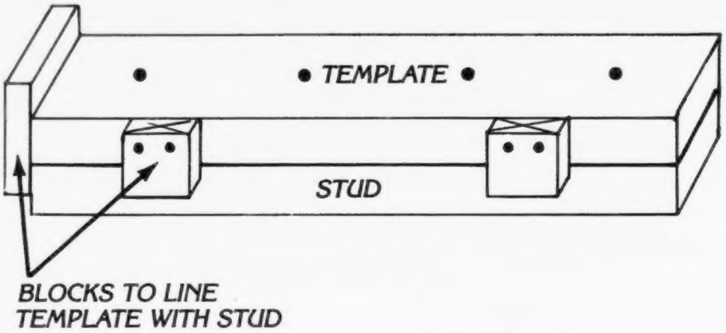
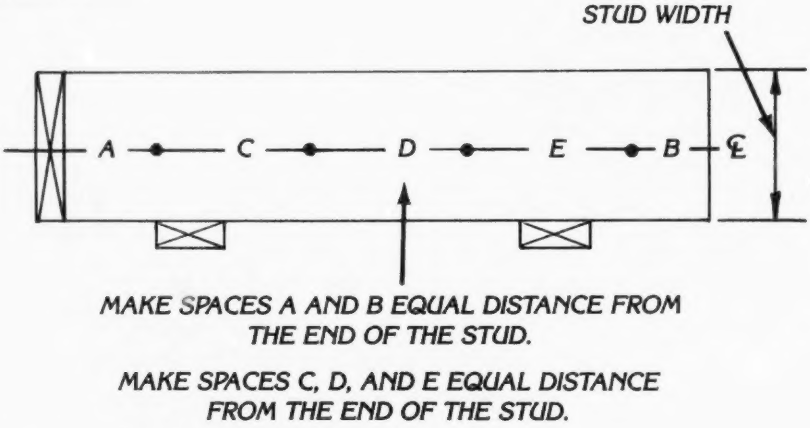

TEMPLATE
STUD
BLOCKS TO LINE TEMPLATE WITH STUD

FIGURE 54


STUD WIDTH
A
C
D
E
B
℄
MAKE SPACES A AND B EQUAL DISTANCE FROM THE END OF THE STUD.
MAKE SPACES C, D, AND E EQUAL DISTANCE FROM THE END OF THE STUD.

3. Drill panel lock bolt holes in end studs

   (NOTE: Pick straight studs.)

4. Place stud in jig

CAUTION
Place predrilled studs at panel ends.

JOB SHEET #4

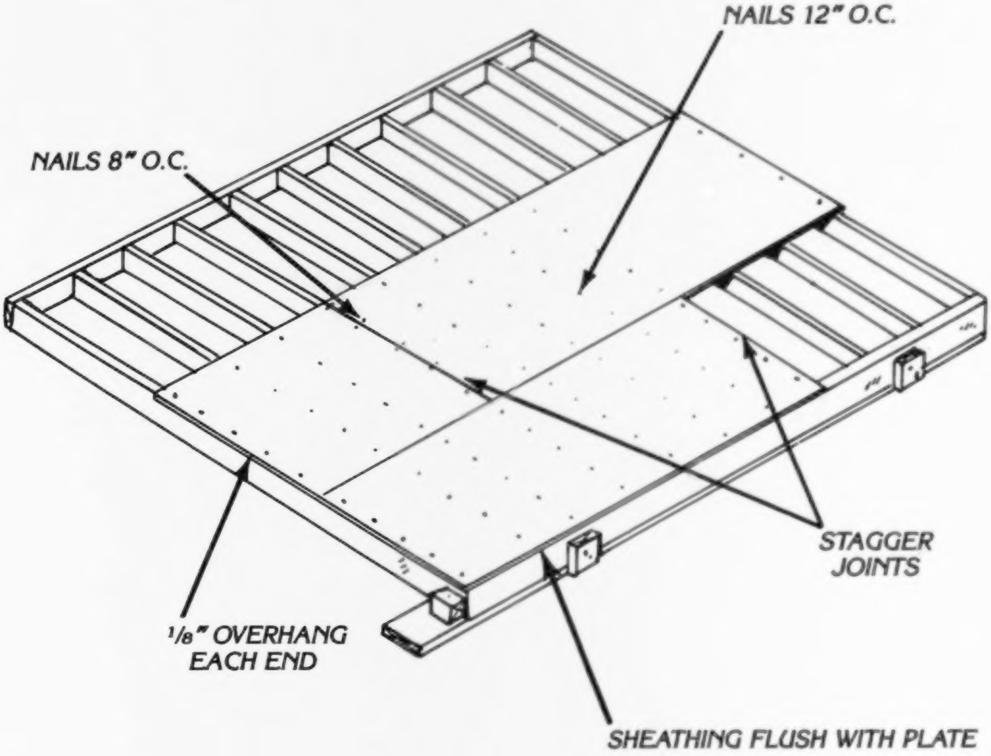
5. Nail plates to studs

6. Pull plate down against plate blocks

7. Sheath panel (Figure 55)

   (NOTE: Plywood may be installed vertically or horizontally with staggered joints.)

FIGURE 55


NAILS 12" O.C.
NAILS 8" O.C.
STAGGER JOINTS
1/8" OVERHANG EACH END
SHEATHING FLUSH WITH PLATE

   a. Tack first sheet with 1/8" overhang on ends and flush with bottom plate

   b. Tack all sheets on panel; check fit

   c. Nail securely

      (NOTE: Use cement-coated, ring shank, or other types of nails with good holding power.)

JOB SHEET #4

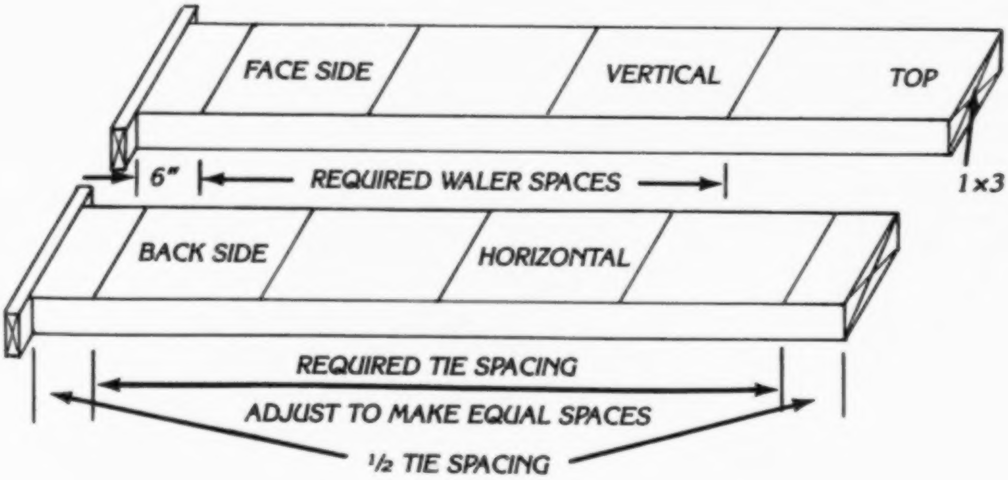
8. Determine tie spacing vertically and horizontally.

   (NOTE: Tie spacing is determined by the type of form system used, the diameter of the ties, and the rate of concrete placement. In this particular circumstance 16" spacing decreases waste.)

9. Make tie spacing template (Figure 56)

   (NOTE: Horizontal and vertical spacings can be laid out on the same template.)

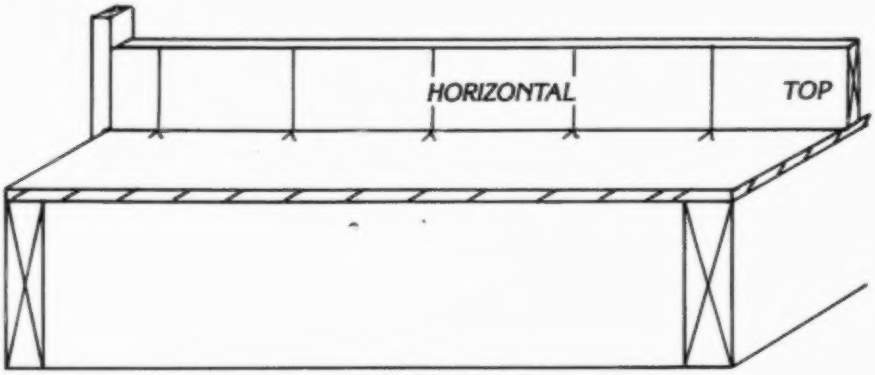
FIGURE 56


FACE SIDE
VERTICAL
TOP
6"
REQUIRED WALER SPACES
1×3
BACK SIDE
HORIZONTAL
REQUIRED TIE SPACING
ADJUST TO MAKE EQUAL SPACES
½ TIE SPACING

(NOTE: Mark sides of template clearly to avoid error and speed up layout.)

10. Mark tie spacing from template on four sides of the panel (Figure 57)

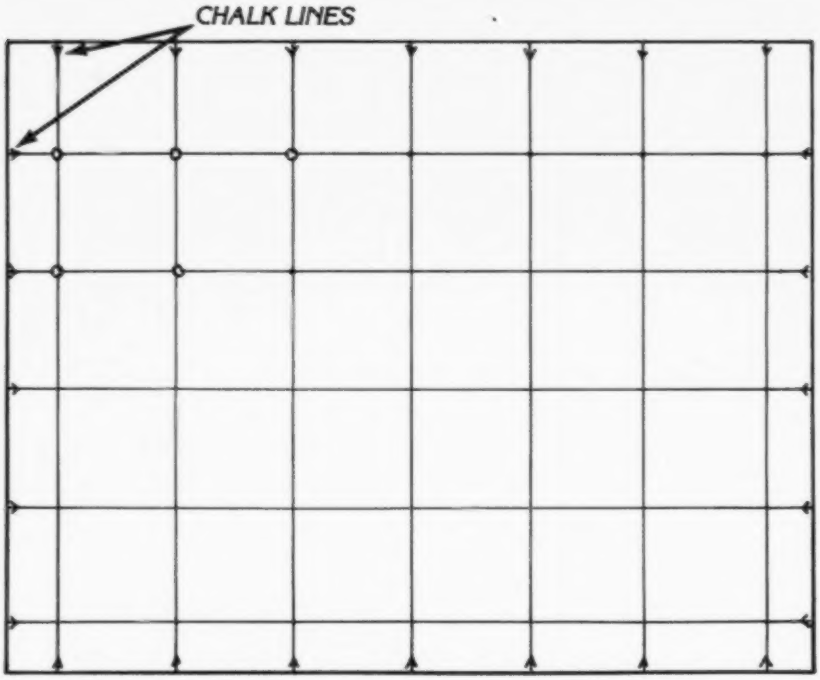
FIGURE 57


HORIZONTAL
TOP

JOB SHEET #4

11. Snap chalk lines to connect all vertical and horizontal points (Figure 58)

FIGURE 58



12. Drill tie holes at all points where chalk lines cross

    (NOTE: Size of hole is determined by size of tie. Tie should fit hole snugly to avoid loss of mortar.)

13. Build the required number of main filler and pilaster panels

D. Locate and set sole plates

   1. Transfer building lines from the batter boards

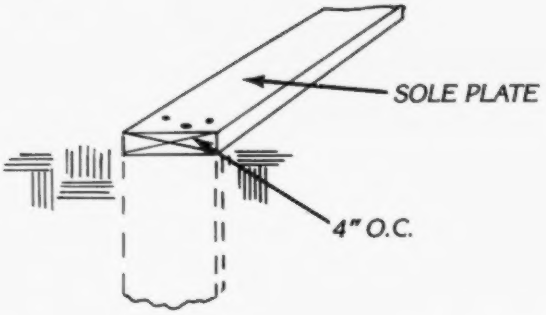
      (NOTE: Use plumb bob.)

      a. For setting on footings, establish corners and snap a chalk line on the footing at the wall line

JOB SHEET #4

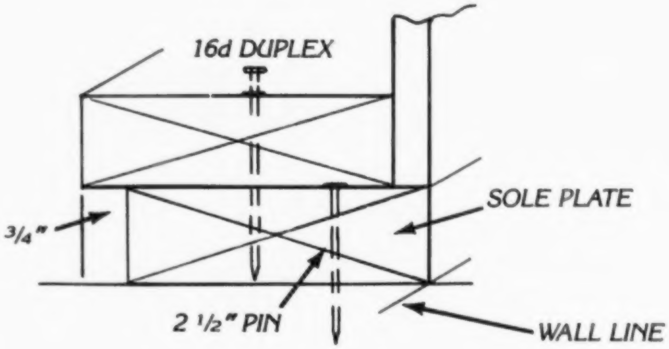
b. For setting without footings, drive stakes to support sole plate and panels (Figure 59)

FIGURE 59


SOLE PLATE
4" O.C.

2. Set sole plates (Figure 60)

FIGURE 60


16d DUPLEX
3/4"
SOLE PLATE
2 1/2" PIN
WALL LINE

E. Erect first side panels

1. Establish location of first panel

   (NOTE: This will assure that tie holes in the two sides are lined up and that filler panels will fit.)

2. Place the first panel on the wall line and secure to sole plate as shown in Figure 60

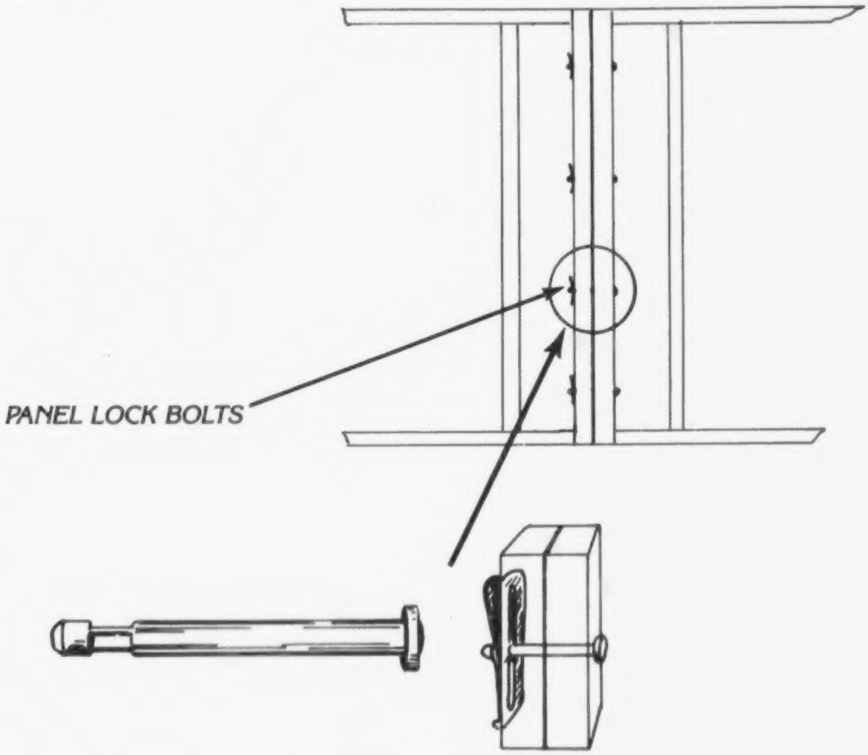
   (NOTE: Attach temporary brace to hold panel plumb.)

JOB SHEET #4

3. Set the adjacent panel in place and secure to first panel with panel lock bolts (Figure 61)

   (NOTE: If panel lock bolts are not available, use machine bolts with washers.)

FIGURE 61

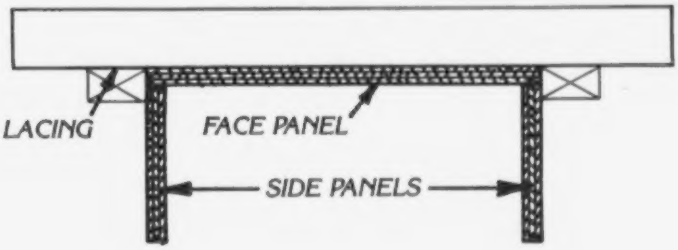


4. Line bottom of panel and nail to sole plate as shown in Figure 60
5. Repeat steps 1 through 4 to continue erection
6. Erect pilaster panels
   a. Erect main or filler panel on each side of the pilaster opening

JOB SHEET #4

b. Nail pilaster side panels to face panel (Figure 62)

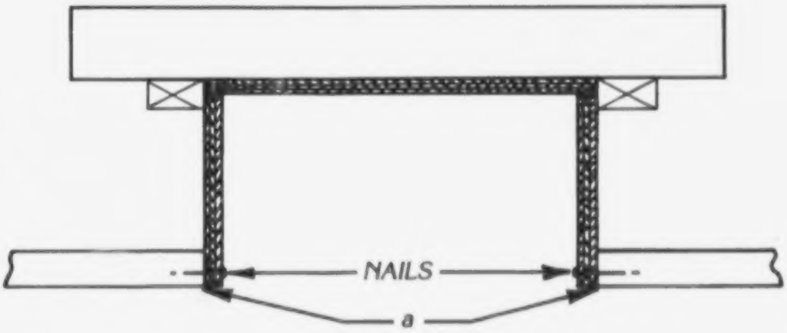
FIGURE 62


LACING
FACE PANEL
SIDE PANELS

c. Stand pilaster form in place and nail side panels to wall panels (Figure 63)

(NOTE: Make points at "a" flush.)

FIGURE 63



7. Install waler blocks or brackets (Figures 64 and 65)

   (NOTE: Be sure horizontal tie holes align with waler slot.)

JOB SHEET #4

8. Set walers on supports and tack to stud as shown in Figure 64 or 65
9. Place ties through form and waler; secure with tie clamp

FIGURE 64

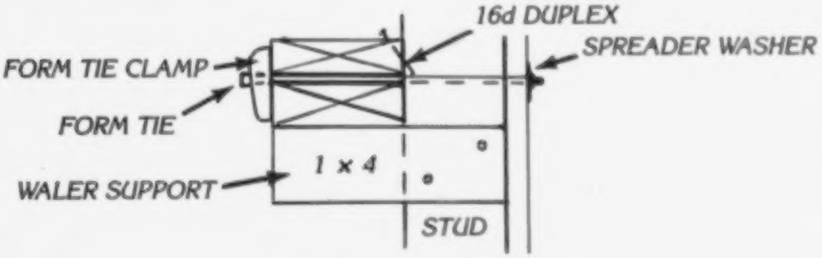
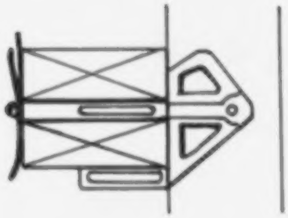
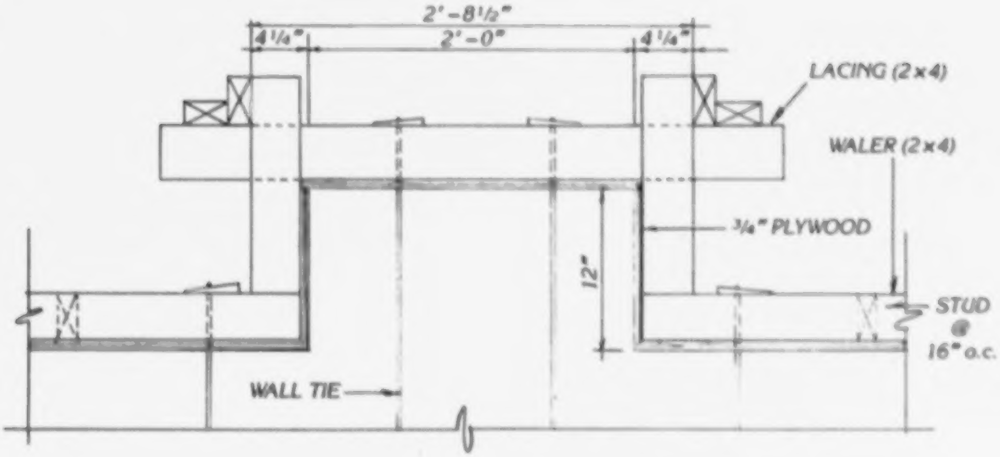

16d DUPLEX
FORM TIE CLAMP
SPREADER WASHER
FORM TIE
1 x 4
WALER SUPPORT
STUD

FIGURE 65



10. Install waler and brace pilaster (Figure 66)

FIGURE 66

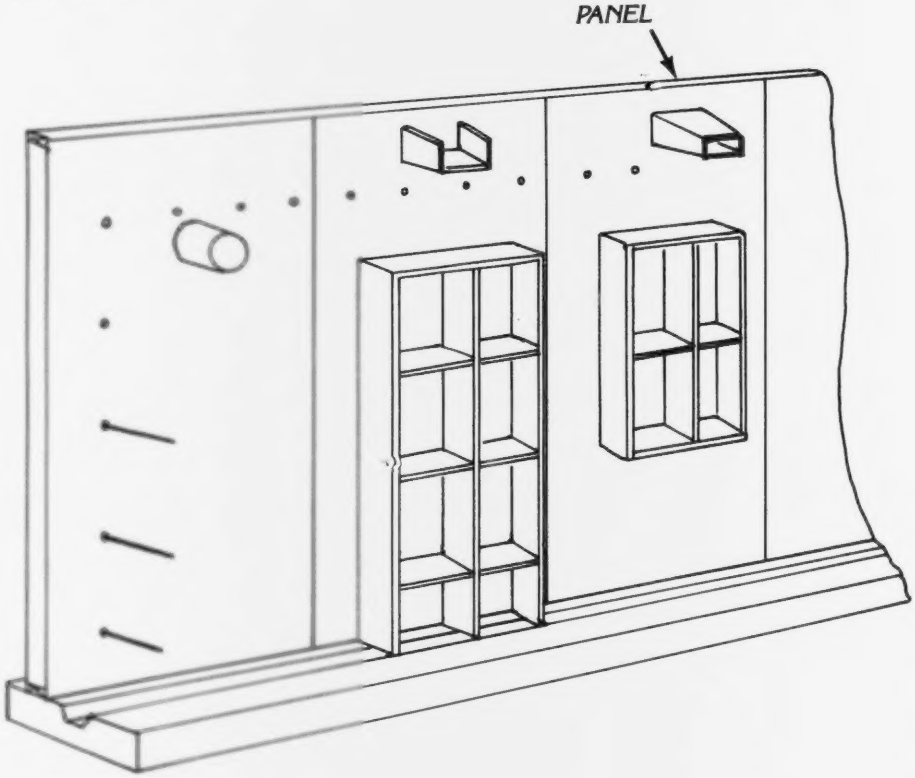

2'-8 1/2"
4 1/4"
2'-0"
4 1/4"
LACING (2×4)
WALER (2×4)
3/4" PLYWOOD
12"
STUD @ 16" o.c.
WALL TIE

JOB SHEET #4

11. Install all sleeves, pockets, or blockouts (Figure 67)

(NOTE: Form oil must be applied before rebars are installed.)

FIGURE 67



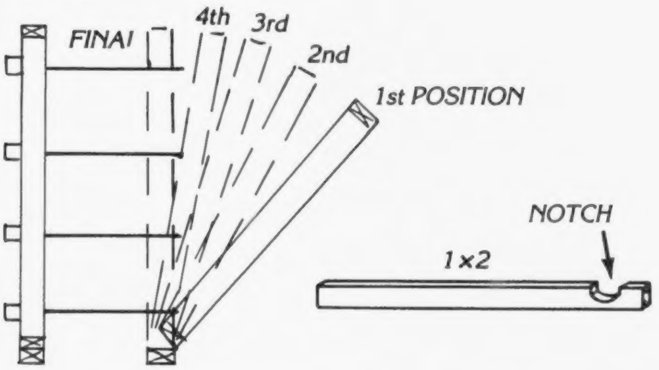
F. Erect second side panels

1. Stand panel on sole plate and, when positioned, tack to sole plate (Figure 68)

(NOTE: Thread ties through predrilled holes by setting panel on sole plate and tipping into place. A notched 1×2 will assist in lining up the ties with the holes.)

JOB SHEET #4

FIGURE 68


FINAl
4th
3rd
2nd
1st POSITION
NOTCH
1×2

2. Place a short waler over one of the upper ties and secure panel with tie clamp

3. Repeat steps 1 and 2 to continue erection

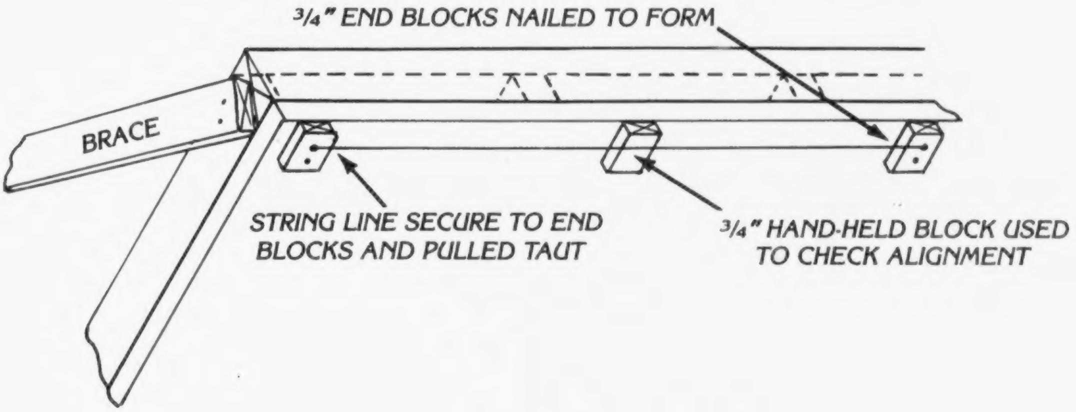
4. Install waler supports as shown in Figure 64 or 65

5. Set walers on supports, place clamps on ties, and tighten

G. Align forms (Figure 69)

(NOTE: Align form with braces placed as needed along form.)

FIGURE 69


3/4" END BLOCKS NAILED TO FORM
BRACE
STRING LINE SECURE TO END BLOCKS AND PULLED TAUT
3/4" HAND-HELD BLOCK USED TO CHECK ALIGNMENT

WALL FORMS
UNIT IV

JOB SHEET #5 — REMOVE FORMS AND PREPARE FOR STORAGE

(NOTE: The part of this job sheet about preparation for storage is only applicable if prefabricated forms are used.)

I. Tools and materials

A. Wrecking bar (crow bar)

B. Claw hammer

C. Wire cutter

D. Large paint brush, mop, or roller

E. Sprayer

F. Tie rod tool

II. Procedure

A. Remove forms

(NOTE: Remove in reverse order from installation.)

1. Remove braces

(NOTE: Care should be taken not to damage the lumber any more than necessary so that it may be reused.)

2. Loosen and remove tie clamps

3. Pull all nails and remove all panel lock bolts holding the form sections together. Remove waler support brackets and walers

4. Strip the forms from the green concrete

(NOTE: Be very careful as you strip the forms as the concrete is still green and can be chipped or damaged very easily at this stage.)

CAUTION

Do not pry against green concrete.

5. Remove all nails from forms that are not to be reused; remove only those nails from prefabricated forms that were used to join panels

JOB SHEET #5

B. Prepare forms for storage

1. Clean the dried concrete from the forms

2. Coat all form surfaces with form oil

3. Stack the form panels face-to-face on a level surface

   (NOTE: Forms should be stacked face-to-face and positioned so that any water will drain from them.)

4. Cover forms with weatherproof covering if they are to remain outside

5. Clean and store all form accessories

WALL FORMS
UNIT IV

TEST

NAME ______________________________ SCORE ______________

1. Match to their correct definitions terms associated with wall forms. Write the correct numbers in the blanks.

______a. Piece of wood cut to thickness of wall and inserted to hold forms temporarily at the correct dimension against tension of the form ties and removed as the pressure of the concrete permits

______b. Recess or groove in one lift of placement of concrete which is filled with concrete of the next lift giving shear strength to the joint

______c. Board placed in a form to cut off the concrete pour

______d. Panel units that have been constructed or assembled prior to using

______e. Single section of a patented or job-built form

______f. Vertical member that is part of the wall projecting from the wall and treated as a column; usually projects a third or less of its width from the wall to help support the wall

______g. Wire or metal cross tie used to hold the pressure of wet concrete and maintain the proper wall thickness

______h. Horizontal brace used in form construction

______i. Prefabricated panels joined together to make a much larger unit for convenience in erecting, stripping, and reusing

______j. Line attached to load to help balance and guide load being hoisted

______k. Wall with an inward slope from bottom to top of face of wall

______l. Strip of wood or metal fastened across a form for temporary positioning or to replace a form tie

1. Prefabricated
2. Form oil
3. Pilaster
4. Waler
5. Keyway
6. Scab
7. Tag line
8. Cleat
9. Keyway strip
10. Gang forms
11. Panel
12. Spreader
13. Battered wall
14. Form tie
15. Bulkhead
16. Waterstop

TEST

_____m. Blend of oils applied to interior surface of forms to prevent concrete from adhering to the forms

_____n. Beveled piece of wood or metal used in a form to form the keyway where future pours will occur

_____o. Piece of material fastened across a splice to strengthen and hold the two pieces together

_____p. Thin sheets of rubber, plastic, or other material inserted in a construction joint to obstruct seepage of water through the joint

2. Name four types of wall forms

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

3. Select from the following list types of materials used to construct wall forms. Write an "X" in the correct blanks.

_____a. Combination fiberglass and wood

_____b. Combination fiberglass and metal

_____c. Fiberglass

_____d. Plastic laminate

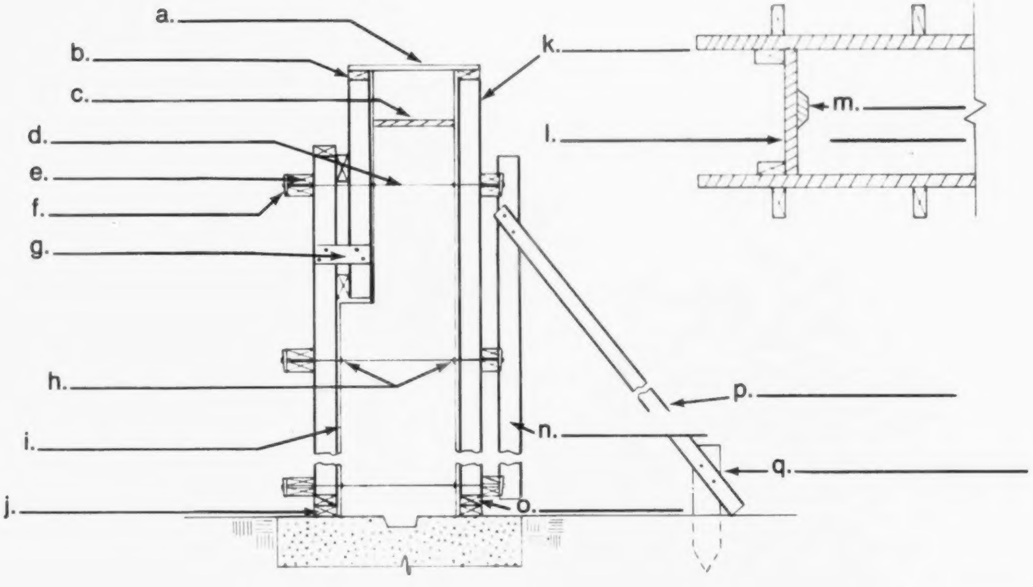
_____e. Metal

_____f. Molded fiber

TEST

4. Identify parts of the wall form illustrated. Write the correct names in the blanks.

Keyway
Bulkhead
Strongback
Brace
Top plate
Sale plate
Bottom plate
Stud
Stake
Cleat
Scab
Spreader washer
Form tie clamp
Sheathing
Form tie
Spreader
Waler



5. Select from the following list advantages of patented panel forms over built-in-place or erected-in-place forms. Write an "X" in the correct blanks.

______a. Cheaper to buy

______b. Slower to strip, therefore protects concrete longer

______c. More reuses of materials

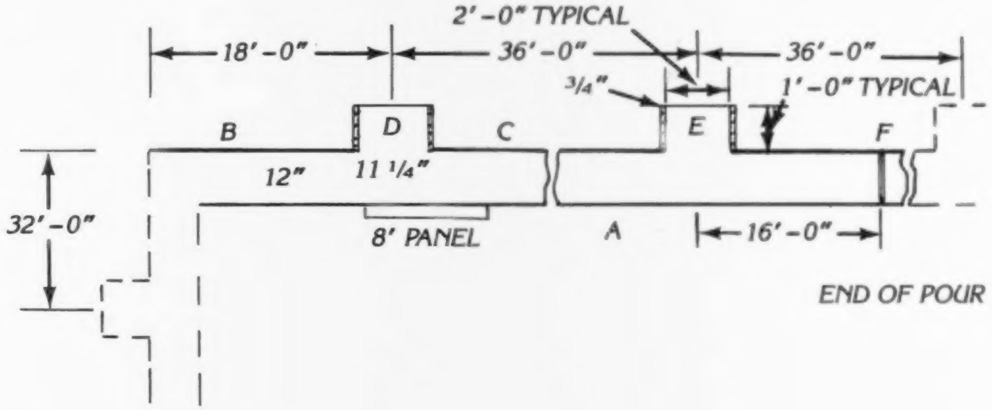
______d. Cleaner to handle

______e. Lighter weight

______f. Ensures a cleaner site

TEST

6. Estimate width and number of panels needed to form the wall section illustrated, assuming horizontal tie spacing is 2′ o.c., main panel is 8′ –0″, and starting location of a main panel as shown.


2′–0″ TYPICAL
18′–0″
36′–0″
36′–0″
3/4″
1′–0″ TYPICAL
B
D
C
E
F
12″
11 1/4″
32′–0″
8′ PANEL
A
16′–0″
END OF POUR

a. Wall A	Width	Number
Main panels —		
Filler panels —		
b. Wall B	Width	Number
Main panels —		
Filler panels —		
c. Wall C		
Main panels —		
Filler panels —		
d. Wall F		
Main panels —		
e. Pilasters D and E		
Face panels —		
Side panels —		

TEST

(NOTE: Test question 7 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

7. Demonstrate ability to

   a. Construct straight wall with patented forms

   b. Construct gang forms for a battered wall

   c. Construct circular wall forms built-in-place

   d. Construct panels forms

   e. Remove forms and prepare for storage

WALL FORMS
UNIT IV

ANSWERS TO TEST

1.

a. 12	e. 11	i. 10	m. 2
b. 5	f. 3	j. 7	n. 9
c. 15	g. 14	k. 13	o. 6
d. 1	h. 4	l. 8	p. 16

2. Answer should include any four of the following

   a. Patented form panel
   b. Job-built form panel
   c. Built-in-place wood form
   d. Erected-in-place patented form
   e. Job-built wood gang form
   f. Patented panel gang form
   g. Steel plate girder form

3. c, d, f

4. a. Cleat
   b. Top plate
   c. Spreader
   d. Form tie
   e. Waler
   f. Form tie clamp
   g. Scab
   h. Spreader washers
   i. Sheathing
   j. Sole plate
   k. Stud
   l. Bulkhead
   m. Keyway strip
   n. Strongback
   o. Bottom plate
   p. Brace
   q. Stake

5. c, f

6. (NOTE: Answers may vary due to methods of estimating.)

Wall A	Width	Number
Main panels —	8′	8
Filler panels —	7′ – 8 1/2″	1
Wall B		
Main panels —	8′	1
Filler panels —	2′ – 11 1/4″	1

ANSWERS TO TEST

Wall C		
Main panels —	8′	4
Filler panels —	1′ – 10½″	1
Wall F		
Main panels —	8′	4
Pilasters D and E		
Face panels —	2′ – 8½″	2
Side panels —	1′ – ¾″	4

7. Performance skills evaluated to the satisfaction of the instructor.

ON-GRADE CURB FORMS
UNIT V

UNIT OBJECTIVE

After completing this unit, the student should be able to construct a straight curb and a curb and gutter form. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with on-grade curb forms.
2. Identify types of curbs and curbs and gutters.
3. Name types of forms used to form curbs and curbs and gutters.
4. Name methods of forming curbs and curbs and gutters.
5. Identify types of median barrier forms.
6. Name methods of forming median barriers.
7. Demonstrate the ability to
    a. Construct straight curb forms.
    b. Construct curb and gutter forms.
    c. Set metal curb and gutter forms with a radius.

ON-GRADE CURB FORMS
UNIT V

SUGGESTED ACTIVITIES

I. Unit contents

A. Objective sheet

B. Suggested activities

D. Transparency masters

1. TM #1 — Types of Job-Built Curb and Gutter Forms

2. TM #2 — Job-Built Straight Curb

D. Information sheet

E. Job sheets

1. Job Sheet #1 — Construct Straight Curb Forms

2. Job Sheet #2 — Construct Curb and Gutter Forms

3. Job Sheet #3 — Set Metal Curb and Gutter Forms with a Radius

F. Test

G. Answers to test

II. Instructor's guide

A. Read unit and plan presentation.

B. Order or obtain materials to supplement the unit.

1. Equipment and materials needed for job sheet performance.

2. Form ties, mule, division plates, hold-down rod, hammer clamp for illustration of terms

3. Transparencies and competency profiles

(NOTE: Transparencies and competency profiles for this manual can be ordered from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

SUGGESTED ACTIVITIES

C. Introduce unit.

SUGGESTIONS:

- Stress the importance of good, solid forms.
- Explain the differences among forms and explain reasons for using particular forms.
- Explain the different methods, techniques, and materials used by different contractors.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

1. Use Information Sheet, Section I to discuss terms and definitions associated with on-grade curb forms.

   SUGGESTION:

   - Show students examples of appropriate terms.

2. Use Information Sheet, Section II to introduce students to types of curbs and curbs and gutters.

   SUGGESTIONS:

   - Use Transparencies #1 and #2 to illustrate your discussion.
   - Take students on a tour of the community, pointing out the various types of curbs and curbs and gutters. Have students discuss why each of the various types was chosen.

3. Use Information Sheet, Section III to discuss methods of forming curbs and curbs and gutters.

   SUGGESTIONS:

   - Demonstrate skills outlined in Job Sheets #1 - #3.
   - Have students complete Job Sheets #1 - #3.

SUGGESTED ACTIVITIES

4. Use Information Sheet, Section IV to introduce students to various types of median barrier forms.

   SUGGESTION:

   - Take students on a tour of the community, pointing out the various types of median barriers.

5. Use Information Sheet, Section V to discuss methods of forming median barriers.

   SUGGESTION:

   - Show students a patented manufactured form and job-built wood forms. Point out the parts of these forms and the functions of each.

H. Give test.

I. Critique test and discuss in class.

J. Reteach and retest if necessary.

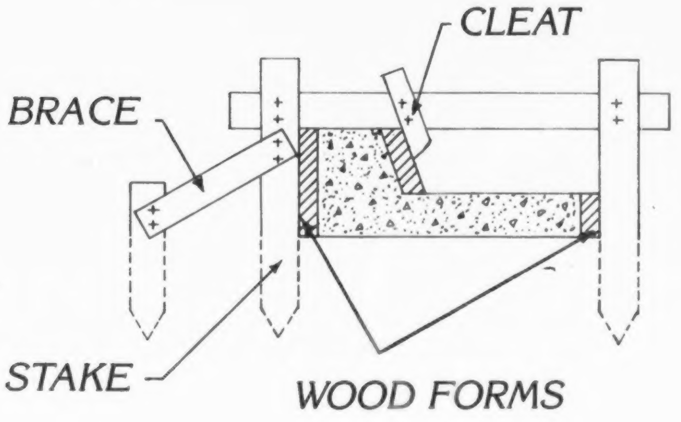
K. Complete appropriate section of competency profiles.

III. Unit references

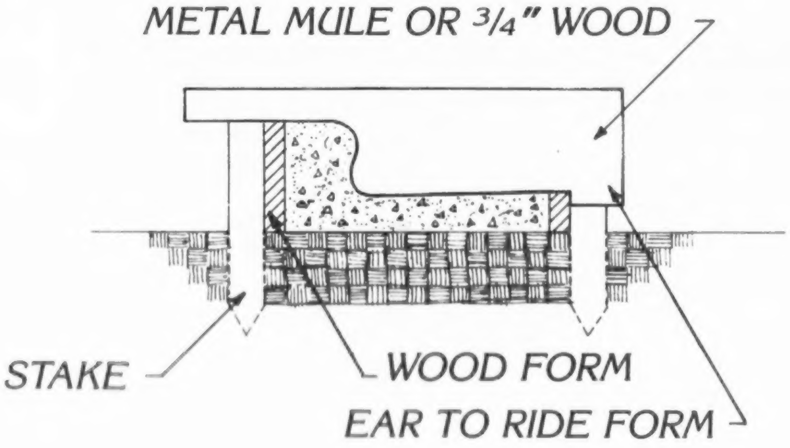
A. Burke, Arthur E.; Dalzell, J. Ralph; and Townsend, Gilbert. *Architectural and Building Trades Dictionary*. Chicago: American Technical Society, 1955.

B. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1979.

Types of Job-Built Curb and Gutter Forms

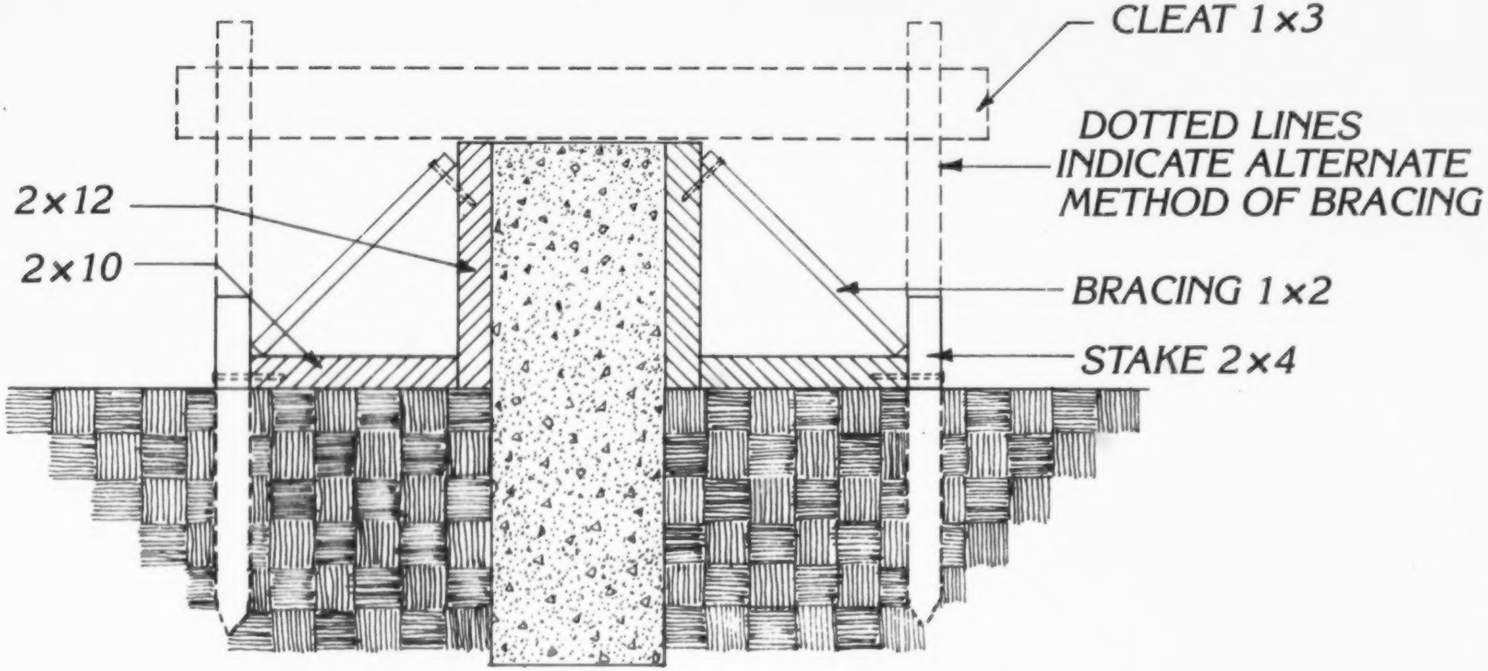

CLEAT
BRACE
STAKE
WOOD FORMS

Curb and Gutter Formed Curb


METAL MULE OR 3/4" WOOD
STAKE
WOOD FORM
EAR TO RIDE FORM

Curb and Gutter Mule Formed Curb

Job-Built Straight Curb


CLEAT 1×3
DOTTED LINES INDICATE ALTERNATE METHOD OF BRACING
2×12
2×10
BRACING 1×2
STAKE 2×4

ON-GRADE CURB FORMS
UNIT V

INFORMATION SHEET

I. Terms and definitions

A. Brace (kicker) — Piece of wood or other material that directs, resists, or supports weight or pressure

B. Cleat — Strip of wood or metal fastened across a form for temporary positioning or to replace a form tie

C. Form snap tie — Wire or metal crosstie used to hold the pressure of wet concrete and maintain the proper wall thickness

D. Monolithic pour — Continuous mass of concrete cast as a single unit

E. Spreader — Block of wood that is used to hold the sides of a form apart and is removed as the concrete is placed; may also be an integral part of the form tie

F. Mule — Template used to shape the profile of a curb or gutter

G. Stakes — Small boards or steel bars pointed on one end and driven into the ground to support a form

H. Division plate — Thin steel plate placed between the forms to provide full depth joints in a curb and gutter

I. Skeleton division plate — Thin steel plate placed between the forms to provide partial depth scoring in curbs and gutters

J. Median barrier — Barrier placed between two lanes of highway

K. Subgrade — Soil prepared and compacted to support a structure or pavement system

L. Battered — Having a receding upward slope on the face of the curb

M. Serpentine curb — Type of curb with several lengthwise curves; resembles serpent

N. Formed stud — Part of a job-built median barrier form used to help support the side of form

O. Holddown rod — Rod designed to hold down forms and to keep them from floating when concrete is placed

P. Hammer clamp — Type of clamp designed for use on curb forms; tightened by hitting the hammer part of the clamp

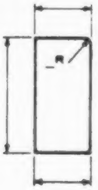
INFORMATION SHEET

II. Types of curbs and curb and gutters (Figures 1-12)

A. Curbs

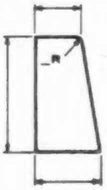
1. Straight

FIGURE 1



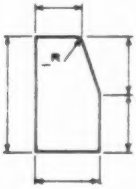
2. Fully battered

FIGURE 2



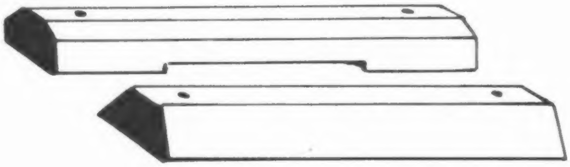
3. Partially battered

FIGURE 3



4. Precast

FIGURE 4

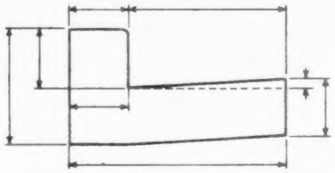


INFORMATION SHEET

B. Curbs and gutters

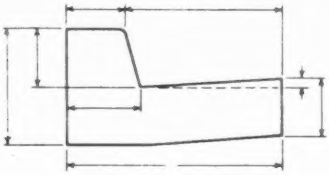
1. Straight face, vertical

FIGURE 5



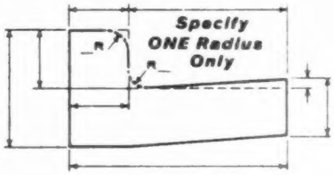
2. Straight face, battered

FIGURE 6



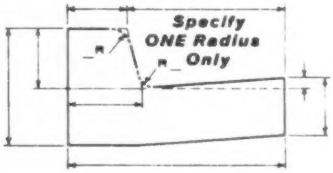
3. Single radius, vertical

FIGURE 7


Specify
ONE Radius
Only
_R
R_

4. Single radius, battered

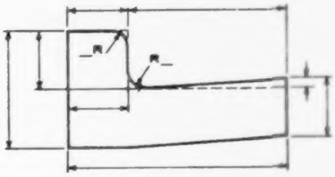
FIGURE 8


Specify
ONE Radius
Only
_R
R_

INFORMATION SHEET

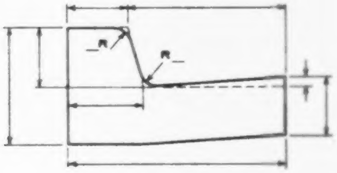
5. Double radius, vertical

FIGURE 9



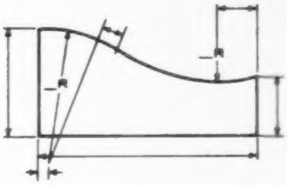
6. Double radius, battered

FIGURE 10



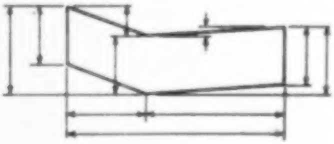
7. Roll-type

FIGURE 11



8. Highway gutter

FIGURE 12

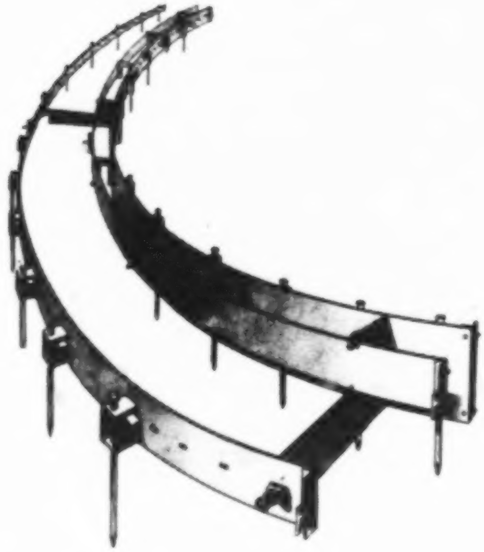


INFORMATION SHEET

III. Types of forms used to form curbs and curbs and gutters (Figures 13-19)

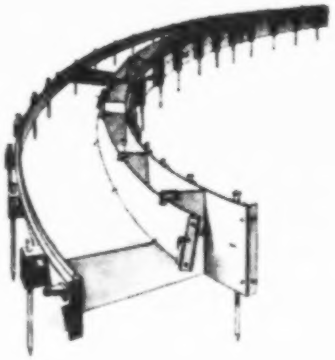
A. Metal flexible radius forms

FIGURE 13



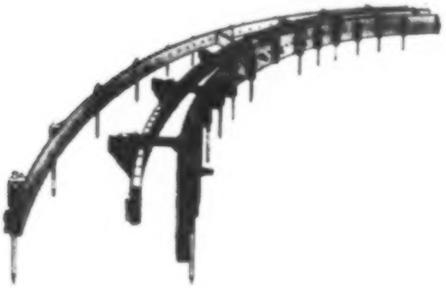
B. Metal fixed radius forms

FIGURE 14



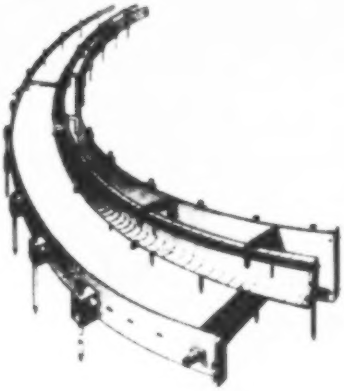
C. Metal straight face form with overhead hangers

FIGURE 15



D. Metal radius face form

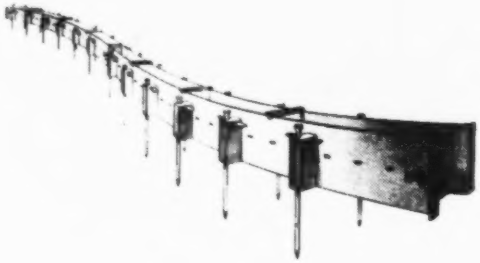
FIGURE 16



INFORMATION SHEET

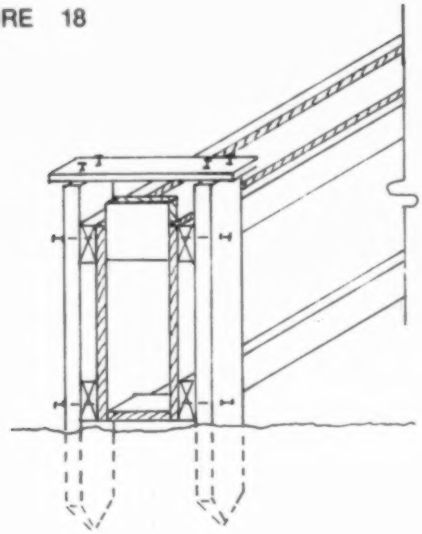
E. Metal serpentine curb form

FIGURE 17



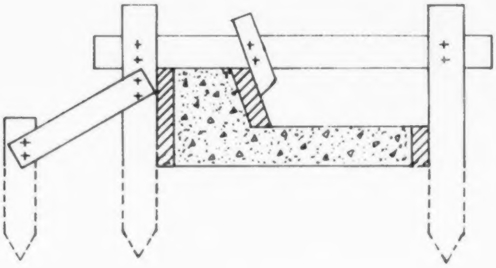
F. Wood curb form (job-built)

FIGURE 18



G. Wood curb and gutter form (job-built)

FIGURE 19

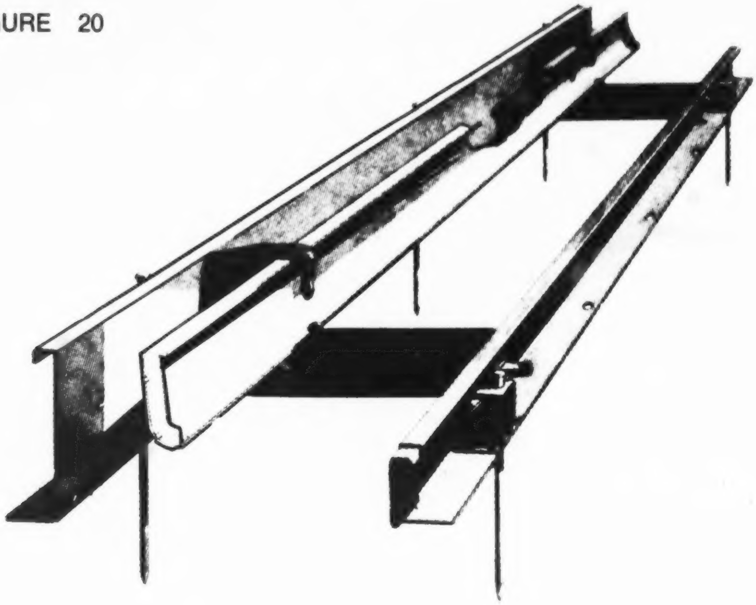


IV. Methods of forming curbs and gutters

A. Patented manufactured forms

EXAMPLE:

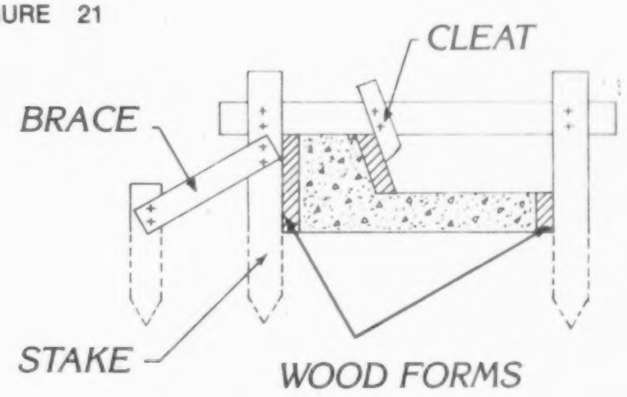
FIGURE 20



INFORMATION SHEET

B. Job-built wood forms

FIGURE 21

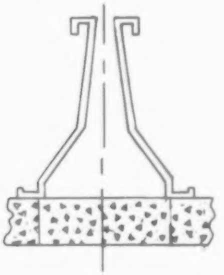

CLEAT
BRACE
STAKE
WOOD FORMS

Curb and Gutter Formed Curb

V. Types of median barrier forms (Figures 22-25)

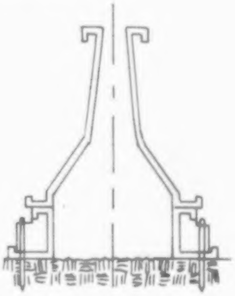
A. Set on slab

FIGURE 22



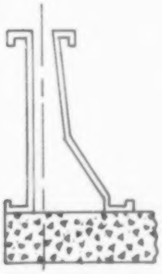
B. Set on subgrade

FIGURE 23



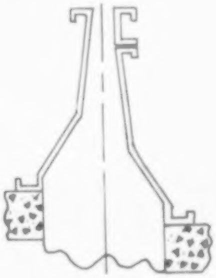
C. One side barrier

FIGURE 24



D. Road surfaces at different elevations

FIGURE 25



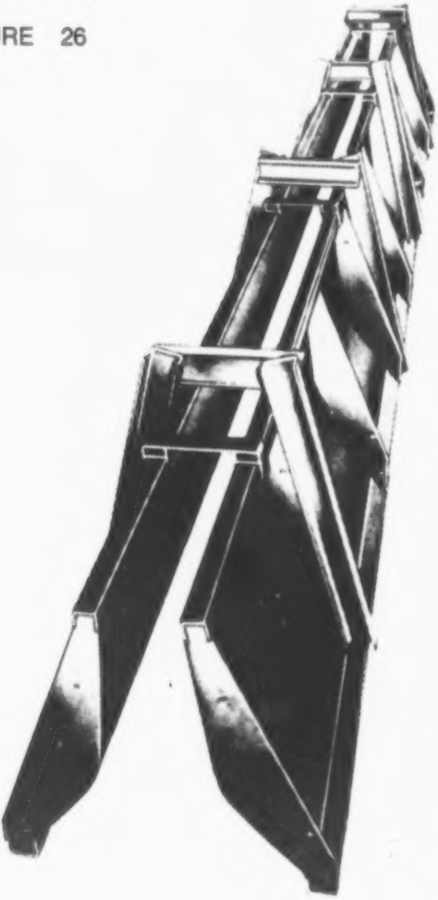
INFORMATION SHEET

VI. Methods of forming median barriers

A. Patented manufactured form

EXAMPLE:

FIGURE 26

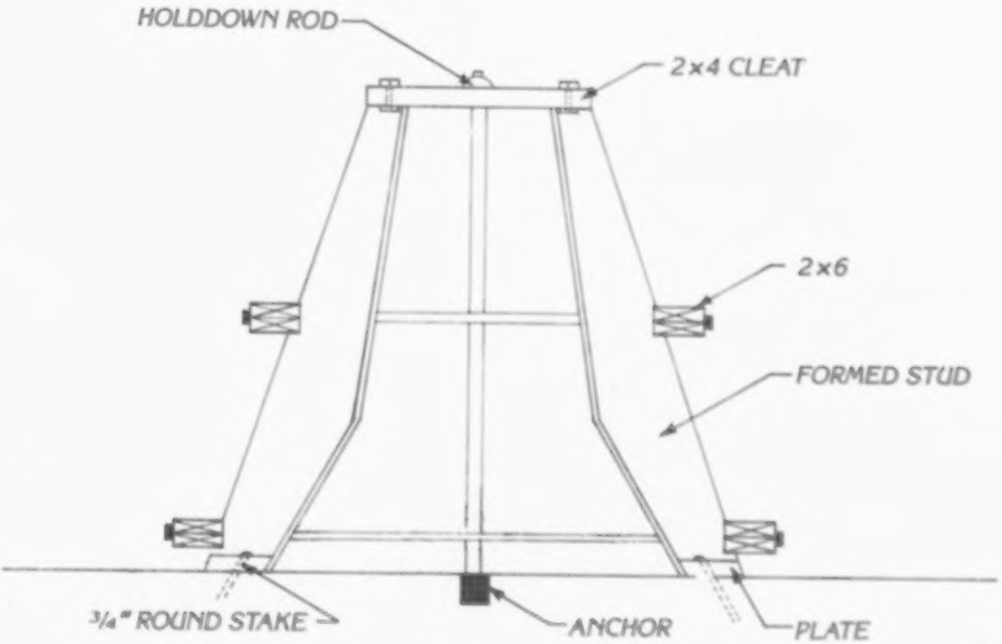


INFORMATION SHEET

B. Job built wood forms

EXAMPLE:

FIGURE 27


HOLDDOWN ROD
2×4 CLEAT
2×6
FORMED STUD
3/4" ROUND STAKE
ANCHOR
PLATE

ON-GRADE CURB FORMS
UNIT V

JOB SHEET #1 — CONSTRUCT STRAIGHT CURB FORMS

I. Tools and materials

  A. Sledge hammer

  B. Claw hammer

  C. Power handsaw and extension cord

  D. Handsaw

  E. One-hundred-foot tape

  F. Folding rule or steel tape

  G. Hand level

  H. Sting line

  I. Builders level and rod

  J. Hammer clamps

  K. 2×4 and 1×4 stakes

  L. 18" form panels

  M. 1×4's for bracing

  N. 8d and 16d duplex nails

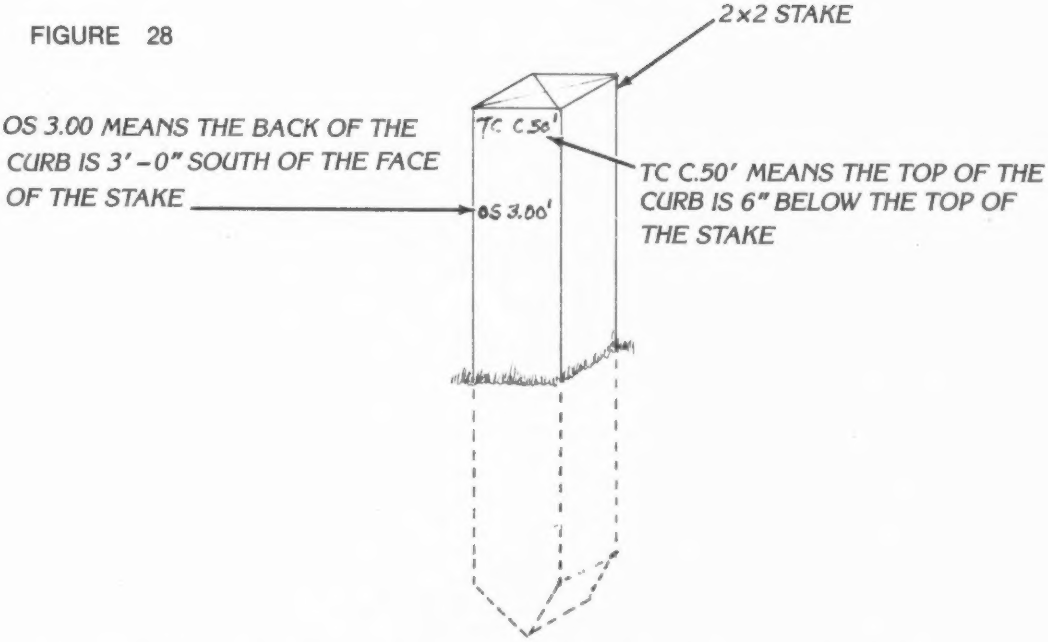
II. Procedure

  A. Establish line of curb (Figure 28)

  (NOTE: Prior to excavation, offset line and grade stakes have been placed along the edge of road. Check these stakes for offset and elevation.)

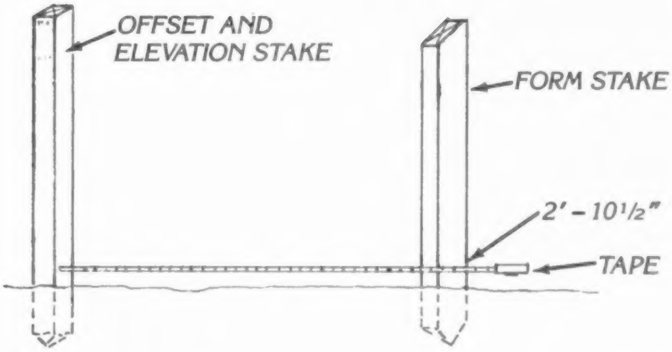
JOB SHEET #1

FIGURE 28


2×2 STAKE
OS 3.00 MEANS THE BACK OF THE CURB IS 3'–0" SOUTH OF THE FACE OF THE STAKE
TC C.50'
OS 3.00'
TC C.50' MEANS THE TOP OF THE CURB IS 6" BELOW THE TOP OF THE STAKE

B. Measure over two feet ten and one-half inches from the south side of offset stake to allow for thickness of form material for form stake location (Figure 29)

FIGURE 29


OFFSET AND ELEVATION STAKE
FORM STAKE
2'–10½"
TAPE

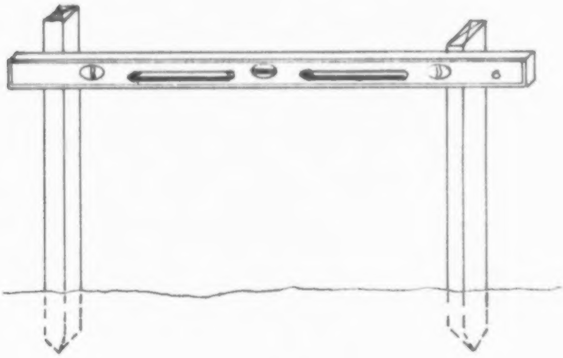
JOB SHEET #1

C. Drive stakes opposite each offset stake

(NOTE: Offset stakes are usually set at 20-foot intervals.)

D. Level over from elevation on offset stake to form stake and mark elevation on form stake (Figure 30)

FIGURE 30



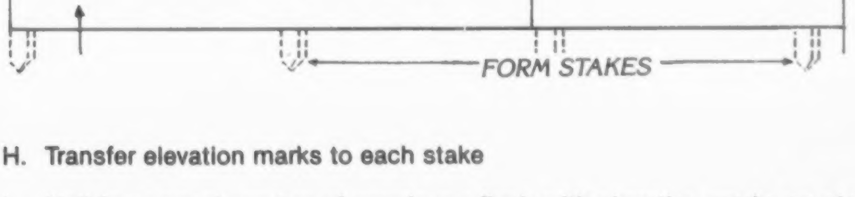
E. Lay form panels end to end along line of curb

F. Attach string line to first form stake on elevation mark and tightly stretch line to next stake and attach to elevation mark, continuing through to last stake

G. Drive all intermediate stakes, spacing them approximately four feet apart; be sure there is a stake at every form panel joint (Figure 31)

(NOTE: Drive stakes straight down, plumb with string line.)

FIGURE 31



H. Transfer elevation marks to each stake

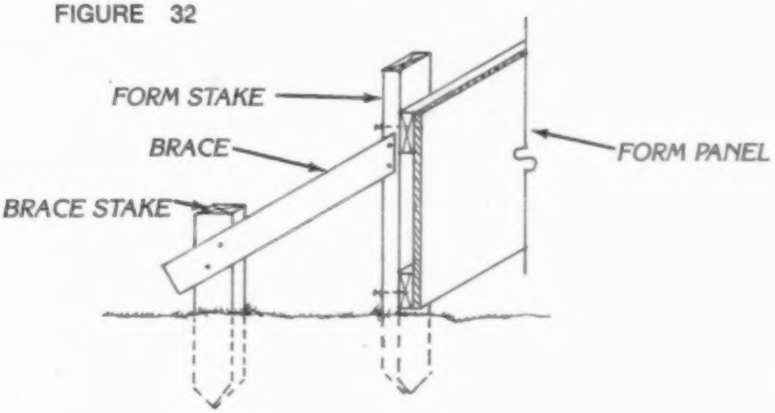
I. Nail form panels so top of panels are flush with elevation marks on stakes

J. Remove line from line stakes

JOB SHEET #1

K. Align forms and brace if necessary (Figure 32)

FIGURE 32

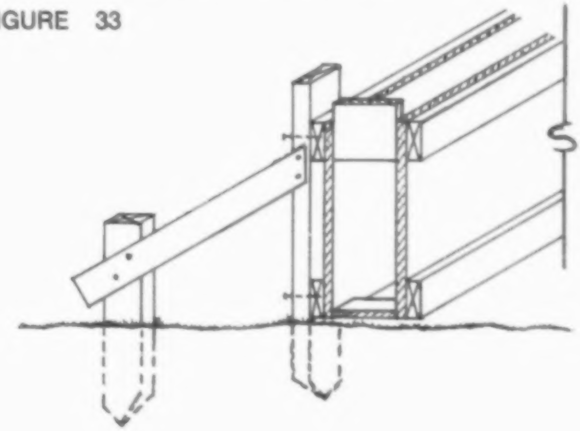

FORM STAKE
BRACE
BRACE STAKE
FORM PANEL

L. Lay out form panels end to end for opposite side of curb

M. Cut six-inch spreaders to fit between the two form panels at top and bottom on each end of panel

N. Stand panel on edge and insert spreaders (Figure 33)

FIGURE 33



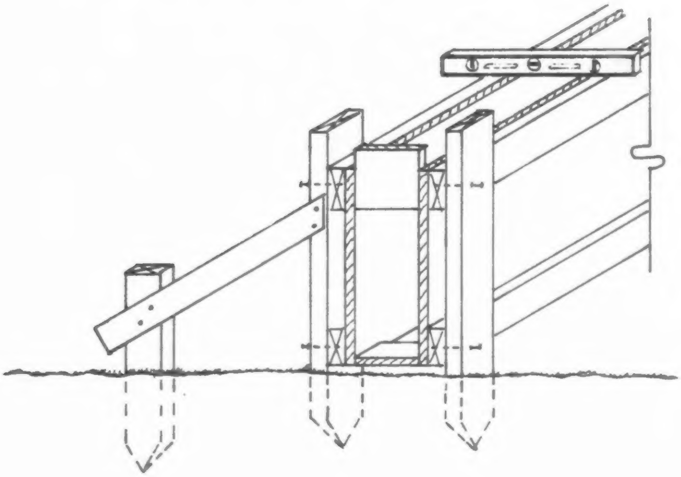
JOB SHEET #1

O. With panel and spreaders in place, start driving stakes snug against the panel with one across from each stake on opposite panel

(NOTE: Drive stakes straight down to keep from applying pressure against opposite panel and forcing it out of alignment.)

P. Nail panels to stakes level with opposite form (Figure 34)

FIGURE 34



JOB SHEET #1

Q. Install hammer clamps or cleats across top of stakes to hold second form in alignment (Figures 35 and 36)

(NOTE: It is not usually necessary to use braces on both sides of curbs. Bottom spreader may be removed after cleats or clamps are installed. Top spreader will be removed as curb is poured.)

FIGURE 35

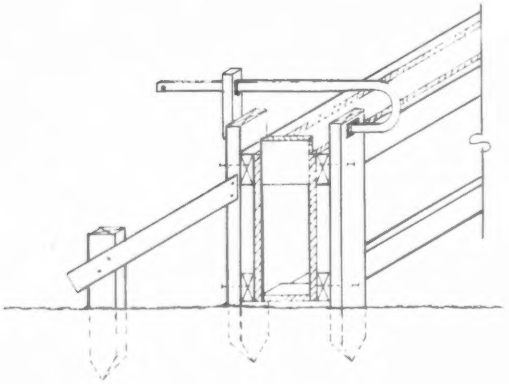
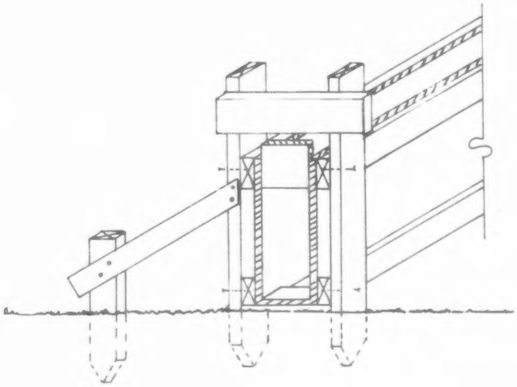


FIGURE 36 — Alternate method



R. Check alignment of form and adjust as needed.

S. Clean up area and put away tools and equipment

ON-GRADE CURB FORMS
UNIT V

JOB SHEET #2 — CONSTRUCT CURB AND GUTTER FORMS

I. Tools and materials

A. Sledge hammer

B. Claw hammer

C. Power handsaw and extension cord

D. Handsaw

E. One-hundred-foot tape

F. Folding rule or steel tape

G. Hand level

H. String line

I. Builder's level and rod

J. Stakes

K. 2×12's and 2×6's for sheathing

L. 8d and 16d duplex nails

M. Hammer clamps

N. 1x4's for bracing and cleats

O. 1×6×2 foot spreaders

P. 1×2×6 inch struts

Q. 1×4 hanger

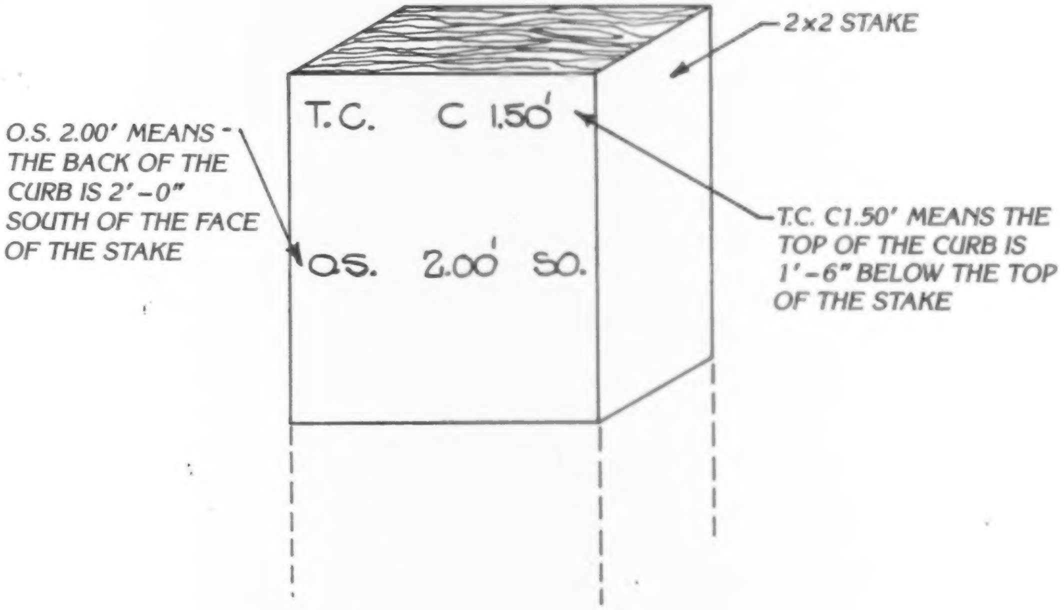
II. Procedure

A. Establish outside line of curb (Figure 37)

(NOTE: Prior to excavation, offset line and grade stakes have been placed on each side of the road. Check these stakes for offset and elevation.)

JOB SHEET #2

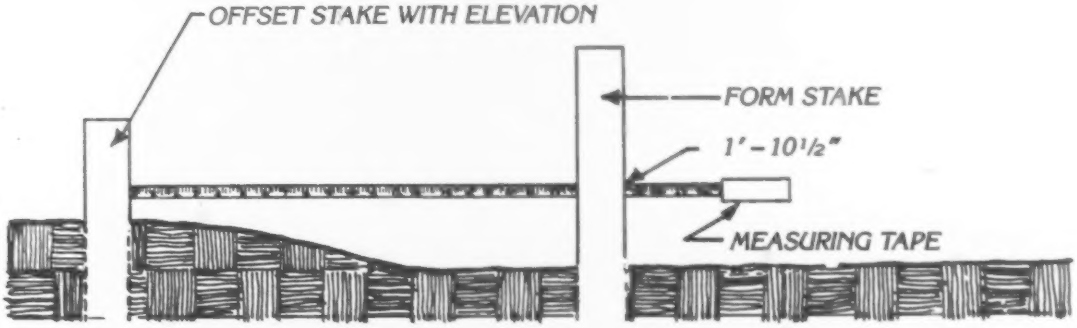
FIGURE 37


2×2 STAKE
T.C. C 1.50'
O.S. 2.00' SO.
O.S. 2.00' MEANS THE BACK OF THE CURB IS 2'-0" SOUTH OF THE FACE OF THE STAKE
T.C. C1.50' MEANS THE TOP OF THE CURB IS 1'-6" BELOW THE TOP OF THE STAKE

B. Measure over one foot ten and one-half inches from south side of offset stake for form stake location (Figure 38)

(NOTE: Be sure to allow for thickness of form material.)

FIGURE 38

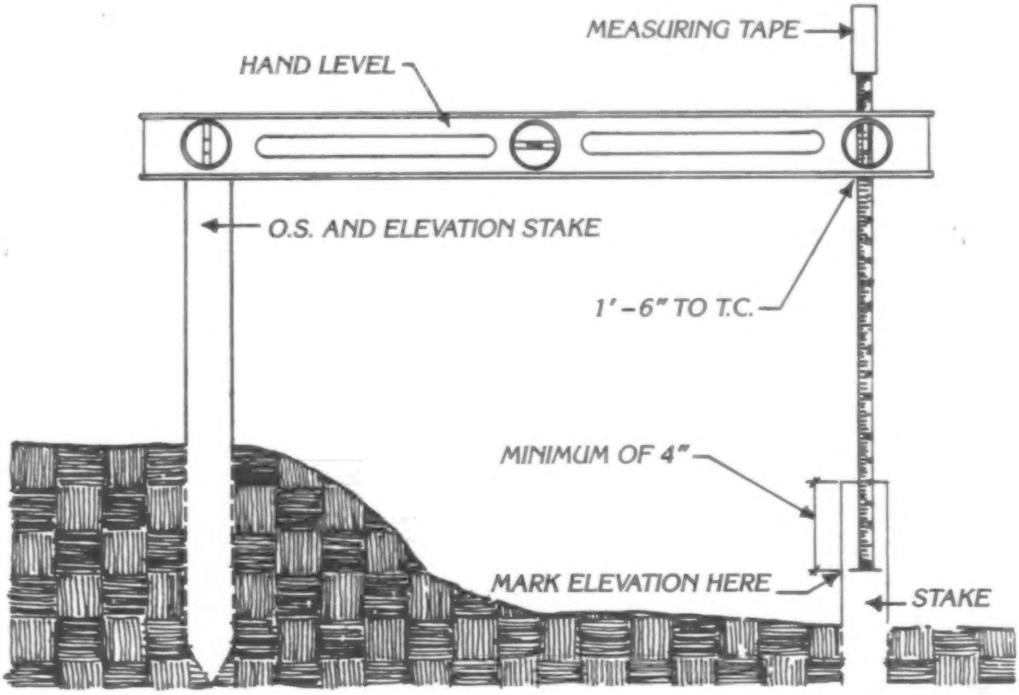

OFFSET STAKE WITH ELEVATION
FORM STAKE
1'-10½"
MEASURING TAPE

JOB SHEET #2

C. Drive stakes opposite each offset stake as shown in Figure 39

(NOTE: Offset stakes are usually set every twenty feet.)

FIGURE 39


MEASURING TAPE
HAND LEVEL
O.S. AND ELEVATION STAKE
1'–6" TO T.C.
MINIMUM OF 4"
MARK ELEVATION HERE
STAKE

D. Level over from elevation on offset stake to form stake and mark elevation on form stake.

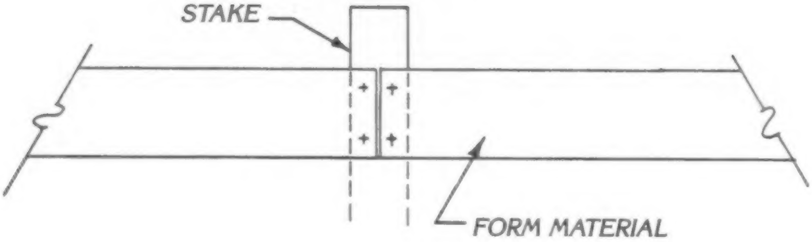
E. Lay form material end to end along line of curb

F. Attach line to stakes at elevation and drive intermediate stakes; mark elevation of T.C. on stakes

(NOTE: Intermediate stakes should be spaced approximately four feet apart, but a stake must be driven at the joint of each length of form material. See Figure 40.)

JOB SHEET #2

FIGURE 40

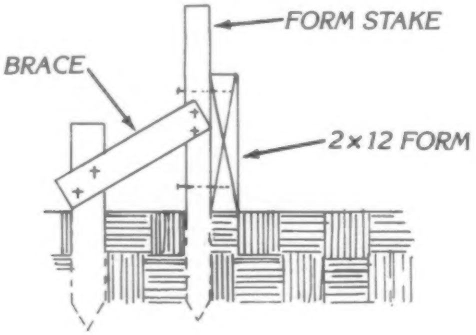

STAKE
FORM MATERIAL

G. Nail form material to stakes with top of form flush with elevation mark on stakes

H. Remove line from line stakes

I. Align forms and brace if necessary (Figure 41)

FIGURE 41

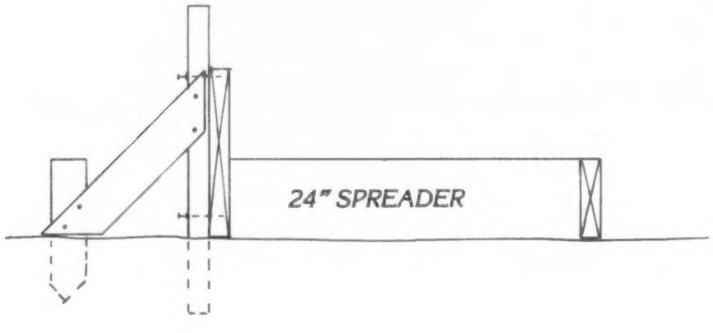

FORM STAKE
BRACE
2×12 FORM

J. Lay out form material end to end for face side of gutter

JOB SHEET #2

K. Stand 2×6 on edge and insert spreader (Figure 42)

FIGURE 42



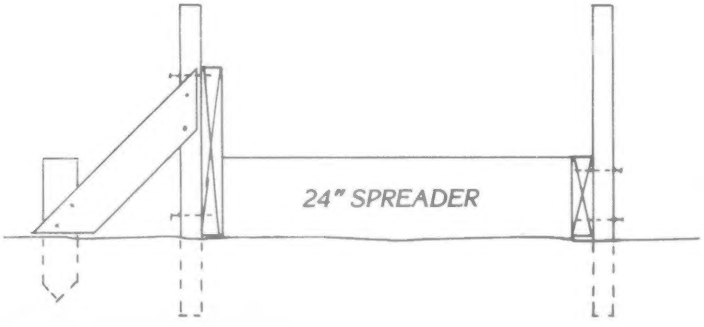
L. With form and spreader in place, drive stakes snug against the panel, driving one across from each stake on opposite form

(NOTE: Drive stakes straight down to keep from applying pressure against opposite form and forcing it out of alignment.)

M. Transfer grade from opposite form to stakes (6" below top of form)

N. Nail form material to stakes with top flush with grade marks on the stakes (Figure 43)

FIGURE 43

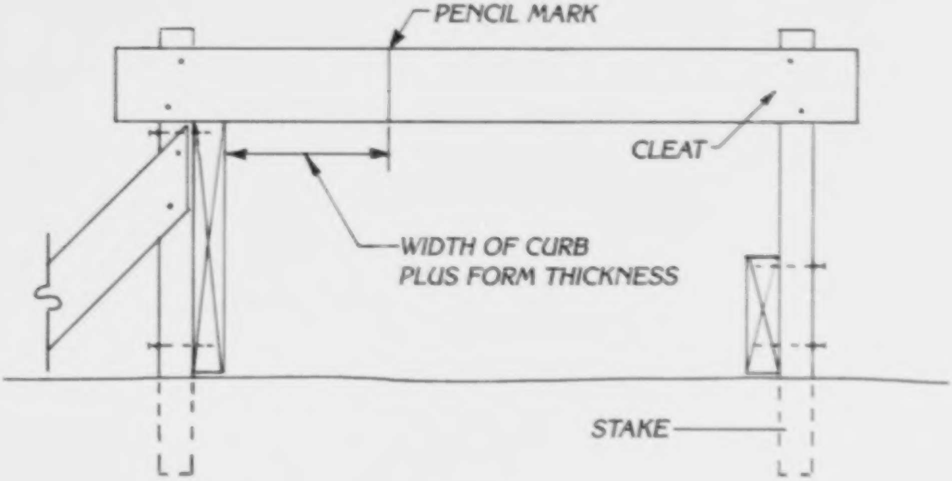


O. Nail cleats across top of stakes to support face form of gutter and also to support inside curb form

JOB SHEET #2

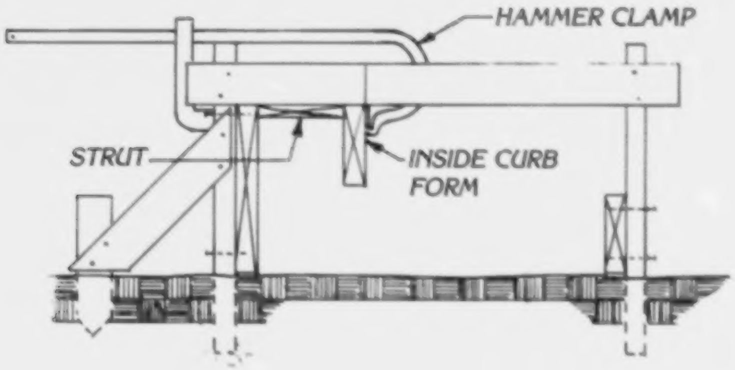
P. Measure from face of back form to face of curb plus thickness of face form and make a mark on the cleat (Figure 44)

FIGURE 44


PENCIL MARK
CLEAT
WIDTH OF CURB
PLUS FORM THICKNESS
STAKE

(NOTE: The inside form may be suspended from stakes if required, but this is a much faster installation. Another method is to clamp the inside curb form to the outside form using hammer clamps and struts [Figure 45].)

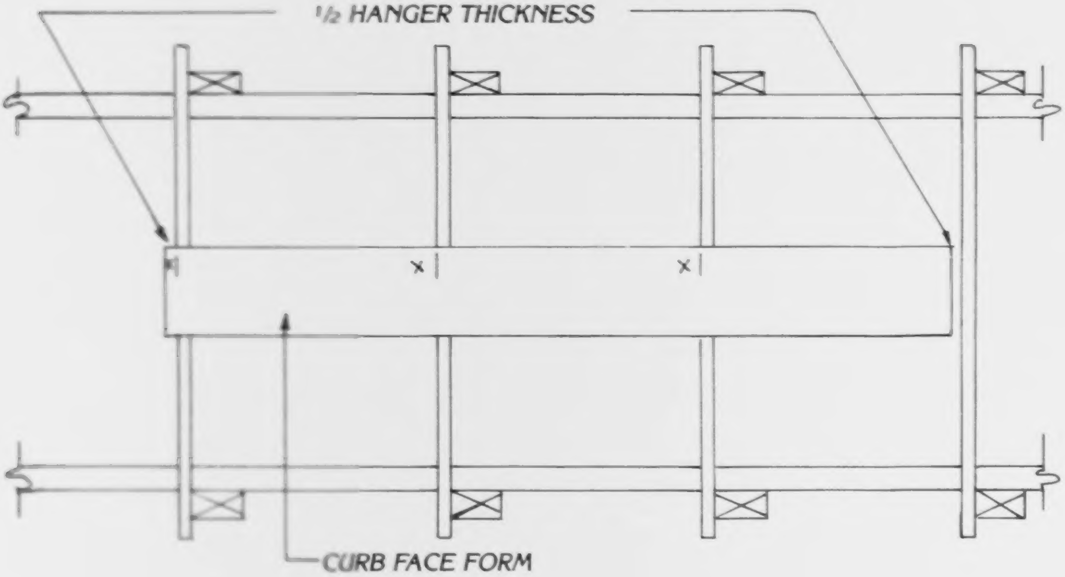
FIGURE 45


HAMMER CLAMP
STRUT
INSIDE CURB
FORM

JOB SHEET #2

Q. Lay face curb forms across top of cleats and lay out hanger location (Figure 46)

FIGURE 46



½ HANGER THICKNESS
CURB FACE FORM

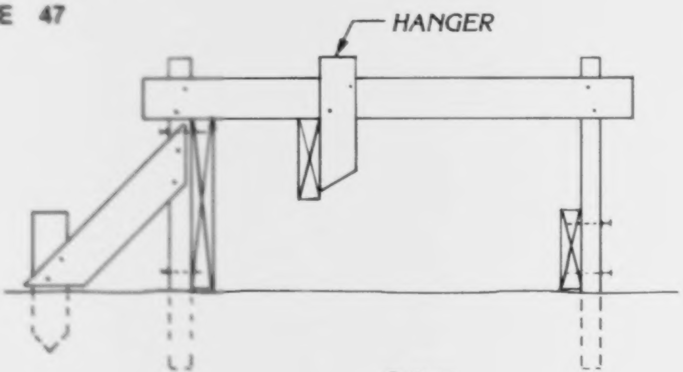
R. Nail hangers to face form

S. Insert face form under cleats and aligned so that hangers can be nailed to cleats

T. Nail hanger to cleats (Figure 47)

(NOTE: All cleats, hangers, and braces should be nailed with 8d duplex nails for easy removal.)

FIGURE 47

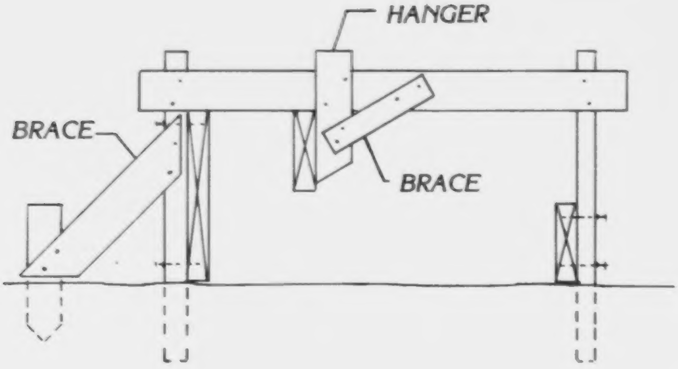


JOB SHEET #2

U. Continue installing hangers and face forms to the cleats until curb is completed

V. Install braces from cleat to hanger if needed (Figure 48)

FIGURE 48



W. Check alignment of form and adjust as needed; add braces to both sides of form if necessary

X. Clean up area and put away equipment and materials

ON-GRADE CURB FORMS
UNIT V

JOB SHEET #3 — SET METAL CURB AND GUTTER FORMS WITH A RADIUS

I. Tools and materials

   A. Sledge hammer

   B. Claw hammer

   C. One-hundred-foot tape

   D. Folding rule or steel tape

   E. Hand level

   F. String line

   G. Builder's level and rod

   H. Patented metal forms and accessories

   I. Metal form stakes

   J. 18" spacers

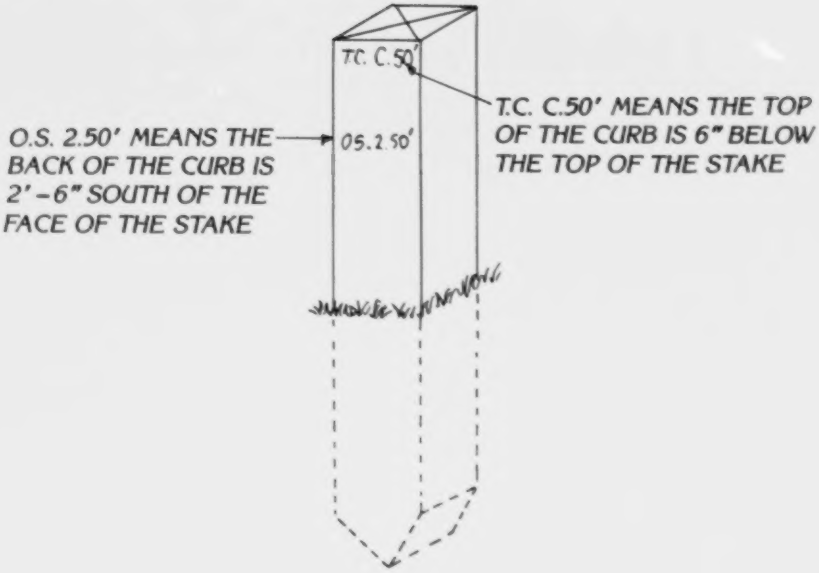
II. Procedure

   A. Establish outside line of curb (Figure 49)

   (NOTE: Prior to excavation, offset line and grade stakes have been placed on each side of the road. Check these stakes for offset and elevation.)

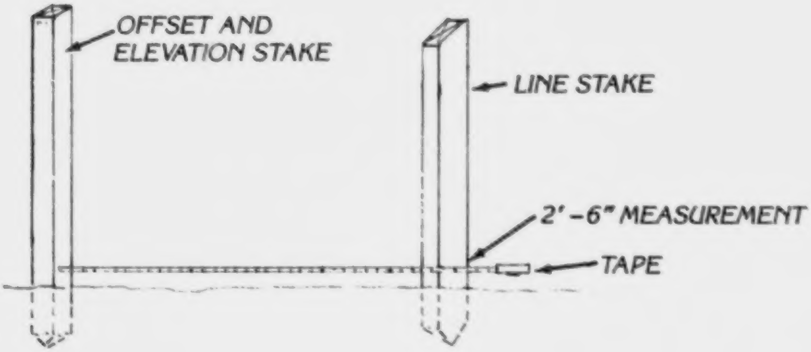
JOB SHEET #3

FIGURE 49


T.C. C.50'
05.2.50'
O.S. 2.50' MEANS THE BACK OF THE CURB IS 2'-6" SOUTH OF THE FACE OF THE STAKE
T.C. C.50' MEANS THE TOP OF THE CURB IS 6" BELOW THE TOP OF THE STAKE

B. Measure over two feet six inches from south side of offset stake for line stake location (Figure 50)

FIGURE 50


OFFSET AND ELEVATION STAKE
LINE STAKE
2'-6" MEASUREMENT
TAPE

C. Drive stakes opposite each offset stake

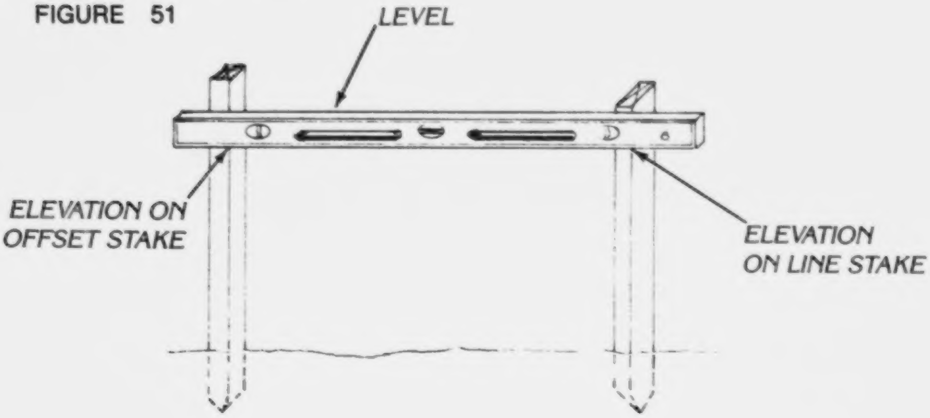
(NOTE: Offset stakes are usually set every twenty feet.)

JOB SHEET #3

D. Measure down six inches from top of offset stake and mark

E. Level over from elevation mark on offset stake to line stake and mark elevation on line stake (Figure 51)

FIGURE 51

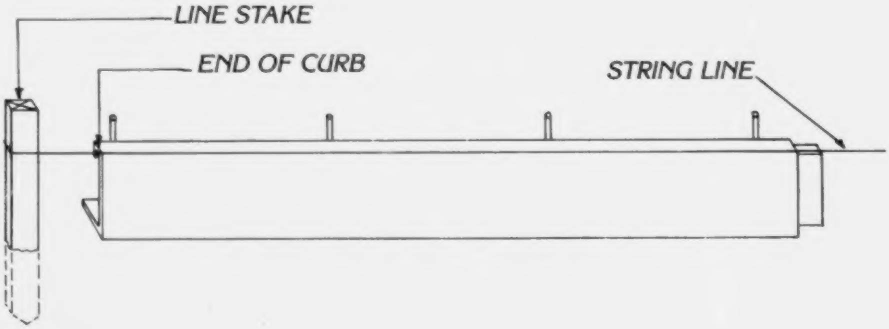

LEVEL
ELEVATION ON OFFSET STAKE
ELEVATION ON LINE STAKE

F. Lay out rear forms end to end along line of curb

G. Attach string line to first line stake on elevation mark and stretch line tight to next line stake on elevation mark; continue through to last stake of the straight run

H. Set first form on ground so that end is even with starting point of curb and face of form is aligned with string line (Figure 52)

FIGURE 52

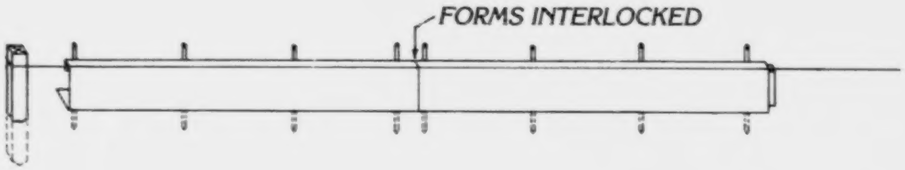

LINE STAKE
END OF CURB
STRING LINE

JOB SHEET #3

I. Drive stakes through form, keeping face of form aligned with string line

J. Butt second form against first form so that they interlock; align face with string line and stake in place (Figure 53)

FIGURE 53



K. Continue following procedures in step "J" until all of rear straight forms are set

L. Align top of rear forms with string line for proper elevation

(NOTE: This may be done with string line or with builder's level and rod.)

1. Raise or lower form until top edge is flush with string line
2. While holding form in this position, strike stake lock with hammer to hold form at proper height

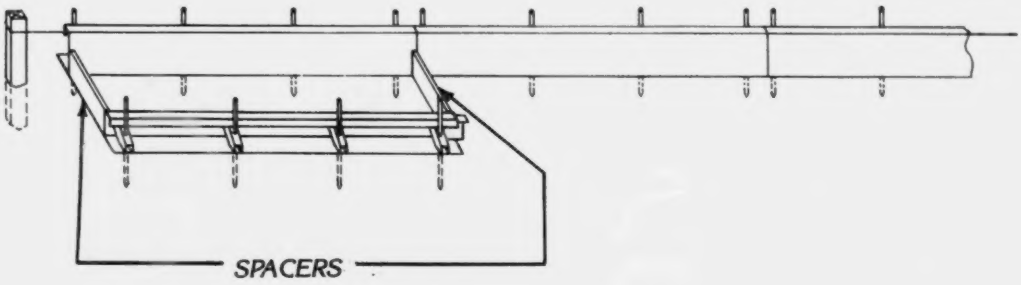
M. Continue aligning forms with string line until all are set

N. Remove string line

O. Lay out front forms end to end along line of curb

P. Place end of spacer against rear form on each end and set front form against them (Figure 54)

FIGURE 54



JOB SHEET #3

Q. Drive stakes in form to hold it in place

R. Remove spacers and move to next form

S. Butt second form against first form so that they interlock and face is tight against spacers and stake in place

T. Continue following procedures in step "S" until all of front straight forms are set

U. Align top of front forms with rear forms for proper elevation

(NOTE: This may be done with level and rule, string line, or with builder's level.)

1. Raise or lower form to proper elevation
2. While holding form in this position, strike stake lock with hammer to hold form at proper height

V. Continue aligning forms until all are set

W. Determine size of radius and lay out radius pivot stake (Figure 55)

1. Measure at right angles from the form the correct distance of radius, 10'-0" for this example
2. Drive radius stake at this point
3. Check measurements again and drive a nail into top of stake at the exact ten foot mark

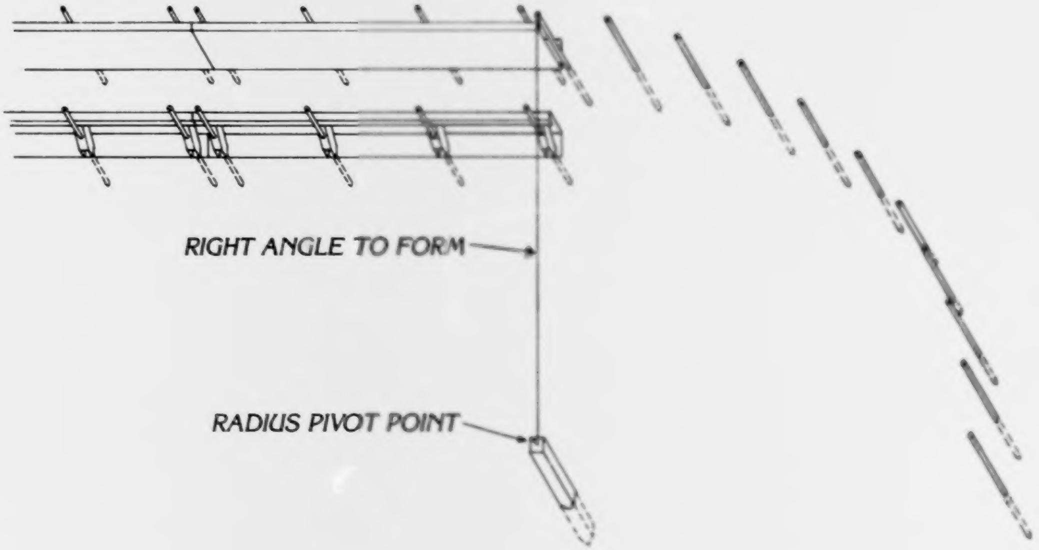
   (NOTE: Be sure stake is set at right angle to form.)
4. Hook end of tape on nail in pivot stake and stretch tape to the form to check measurement

   (NOTE: If adjustment is necessary, force stake over enough to compensate for difference.)
6. Attach end of radius form to end of straight form and bend it around the radius
7. Pull tape tight and check form at each stake as you work around the radius

   (NOTE: Be sure to drive stakes plumb.)

JOB SHEET #3

FIGURE 55



Y. Follow same procedures in step "W" to set front form or use the spacer method as in steps "P-Q"

Z. Set curb face form

   1. Start at one end and attach overhead hangers to rear form

   2. Attach face form to hangers

AA. Recheck forms for alignment; adjust as needed

BB. Recheck elevation of forms with builder's level and rod by spot checking every five or six feet

CC. Clean up area and put away tools and equipment

ON-GRADE CURB FORMS
UNIT V

TEST

NAME ____ SCORE ________________

1. Match the terms on the right to their correct definitions by placing the appropriate numbers in the blanks provided.

______a. Piece of wood or other material that directs, resists, or supports weight or pressure

______b. Strip of wood or metal fastened across a form for temporary positioning or to replace a form tie

______c. Having a receding upward slope on the face of the curb

______d. Wire or metal crosstie used to hold the pressure of wet concrete and maintain the proper wall thickness

______e. Type of curb with several lengthwise curves; resembles serpent

______f. Continuous mass of concrete cast as a single unit

______g. Block of wood that is used to hold the side of a form apart and is removed as the concrete is placed; may also be an integral part of the form tie

______h. Part of a job-built median barrier form used to help support the side of form

______i. Template used to shape the profile of a curb or gutter

______j. Rod designed to hold down forms and to keep them from floating when concrete is placed

______k. Small boards or steel bars pointed on one end and driven into the ground to support a form

______l. Thin steel plate placed between the forms to provide full depth joints in a curb and gutter

______m. Thin steel plate placed between the forms to provide partial depth scoring in curbs and gutters

1. Division plate
2. Stakes
3. Median barrier
4. Brace or kicker
5. Subgrade
6. Skeleton division plate
7. Cleat
8. Monolithic pour
9. Mule
10. Form snap tie
11. Spreader
12. Battered
13. Serpentine curb
14. Formed stud
15. Holddown rod
16. Hammer clamp

TEST

______n. Type of clamp designed for use on curb forms; fastened by hitting the hammer part of the clamp

______o. Barrier placed between two lanes of highway

______p. Soil prepared and compacted to support a structure of pavement system

2. Identify the types of curbs and curbs and gutters illustrated below and on the next page. Place the numbers of the illustrations in the correct blanks.

______a. Partially battered curb

______b. Highway gutter

______c. Double radius, battered

______d. Single radius, vertical

______e. Straight face, vertical

______f. Single radius, battered

______g. Straight faced, battered

______h. Roll type

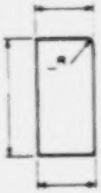
______i. Precast

______j. Fully battered curb

______k. Straight curb

______l. Double radius, vertical

1



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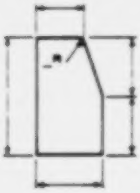

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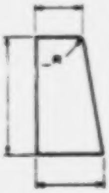

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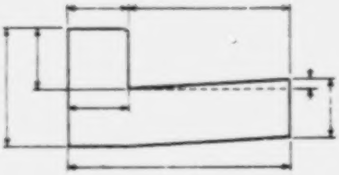

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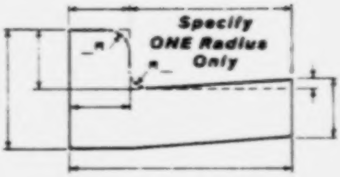

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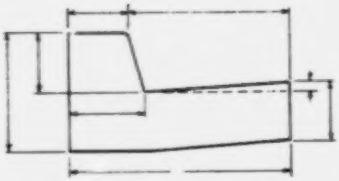

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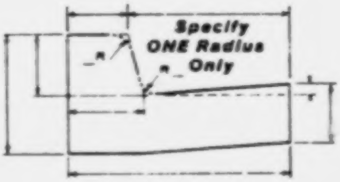
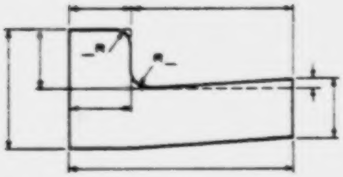


TEST

8



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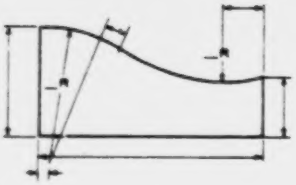

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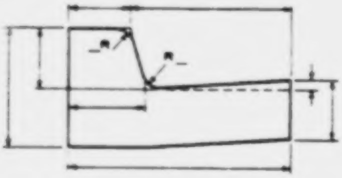

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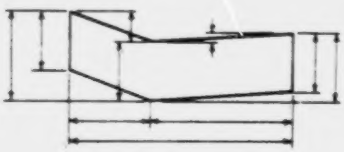

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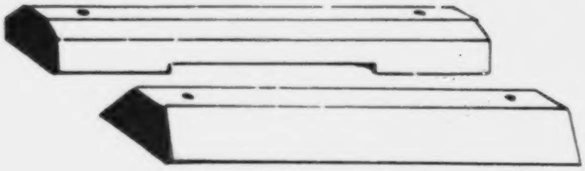


3. Name three types of forms used to form curbs and curbs and gutters.

   a. ______________________________

   b. ______________________________

   c. ______________________________

4. Name the methods of forming curbs and gutters.

   a. ______________________________

   b. ______________________________

TEST

5. Identify the types of median barrier forms illustrated below. Place the correct numbers in the blanks provided.

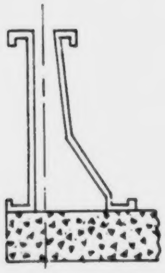
   _____a. Set on slab

   _____b. Set on subgrade

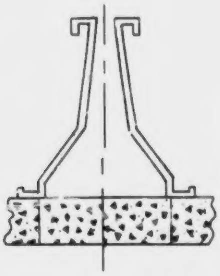
   _____c. One side barrier

   _____d. Road surfaces at different elevations

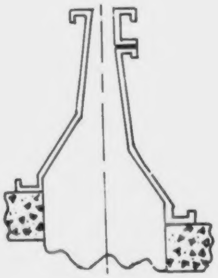
1



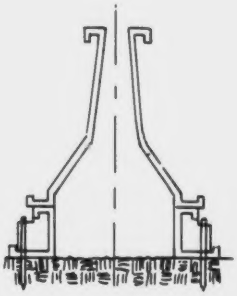
2



3



4



6. Name methods of forming median barriers

   a. ______________________________

   b. ______________________________

(NOTE: Test question 7 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

7. Demonstrate ability to

   a. Construct straight curb forms.

   b. Construct curb and gutter forms.

   c. Set metal curb and gutter forms with a radius.

ON-GRADE CURB FORMS
UNIT V

ANSWERS TO TEST

1. a. 4
   b. 7
   c. 12
   d. 10
   e. 13
   f. 8
   g. 11
   h. 14
   i. 9
   j. 15
   k. 2
   l. 1
   m. 6
   n. 16
   o. 3
   p. 5

2. a. 2
   b. 11
   c. 10
   d. 5
   e. 4
   f. 7
   g. 6
   h. 9
   i. 12
   j. 3
   k. 1
   l. 8

3. Answer should include any three of the following

   a. Flexible radius forms
   b. Fixed radius forms
   c. Straight face form with overhead hangers
   d. Radius face form
   e. Serpentine curb

4. a. Patented manufactured forms
   b. Job-built wood forms

5. a. 2
   b. 4
   c. 1
   d. 3

6. a. Patented manufactured forms
   b. Job-built wood forms

7. Performance skills evaluated to the satisfaction of the instructor.

VERTICAL PIERS AND COLUMNS
UNIT VI

UNIT OBJECTIVE

After completing this unit, the student should be able to identify different types of column shapes and should be able to construct and set various types of column forms. The student will show this knowledge by completing the job sheets and the unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with vertical piers and columns
2. List factors that influence column form design.
3. Identify column shapes.
4. Name common types of materials used for column forms.
5. Identify types of clamps or yokes used on column forms.
6. Name methods of column form construction.
7. Demonstrate the ability to
    a. Construct forms for a square column.
    b. Set a round column form (fiberboard tube).
    c. Construct forms for a round, fluted column.

VERTICAL PIERS AND COLUMNS
UNIT VI

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Transparency master: TM #1 — Column Form Material

   D. Information sheet

   E. Job sheets

      1. Job Sheet #1 — Construct Forms for a Square column

      2. Job Sheet #2 — Set a Round Column (Fiberboard Tube)

      3. Job Sheet #3 — Construct Forms for a Round Fluted Column

   F. Test

   G. Answers to test

II. Instructor's guide

   A. Review unit and plan presentation.

   B. Order or obtain materials to supplement unit.

      1. Equipment and materials for job sheets procedures

      2. Examples of the different types of column form materials

      3. Transparency and competency profiles

         (NOTE: The transparency and competency profiles for this manual are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; 202-393-2040.)

      4. Resource books

         a. Latest edition of *Modern Carpentry* by Willis H. Wagner

            (NOTE: Order from the Goodheart-Willcox Company, 123 West Taft Drive, South Holland, Illinois 60473.)

SUGGESTED ACTIVITIES

b. *Cement Masonry* by Laborn J. "Bud" Hendrix

(NOTE: Order from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

C. Provide students with unit.

D. Introduce unit.

SUGGESTIONS:

- Stress the importance of good, solid forms.
- Explain the differences between vertical piers and columns and other types of forms.
- Discuss unit and specific objectives.

E. Discuss information and job sheets.

1. Use Information Sheet, Section I to introduce the student to terms associated with vertical piers and columns.

   SUGGESTION:

   - Show students examples of appropriate terms.

2. Use Information Sheet, Section II to discuss factors that influence form design.

   SUGGESTION:

   - Explain how each of these factors influence form design.

3. Use Information Sheet, Section III to introduce the various column shapes.

   SUGGESTIONS:

   - Ask students to spend an afternoon or weekend surveying the community. Have them list the column shapes that they discover and the location of each. Compare the lists in class and discuss.
   - Take the students on a field trip around the community. Point out and discuss the various column shapes encountered.
   - Make a bulletin board of pictures of various shapes of columns cut from magazines and pamphlets.

SUGGESTED ACTIVITIES

4. Use Information Sheet, Section IV to discuss the common types of materials used for column forms.

   SUGGESTIONS:

   - Show students examples of the various types of materials.
   - Use Transparency #1 to illustrate your discussion.
   - Explain the reasons for using one type of material over another.

5. Use Information Sheet, Section V to introduce students to the different types of clamps and yokes used in pier and column form construction.

   SUGGESTIONS:

   - Show students examples of as many types of clamps and yokes as possible.
   - Take students to construction sites in the community at which various clamps and yokes are being used.

6. Use Information Sheet, Section VI to discuss methods of column form construction.

   SUGGESTIONS:

   - Explain the different methods, techniques, and materials used by different contractors.
   - Explain the reasons for using one method over another.
   - Take students to construction sites in the community so that they may see column and pier forms being constructed.
   - Demonstrate and discuss procedures outlined in Job Sheets #1 through #3. Review use of the powder-actuated tool if it will be used, and stress safety rules and certification requirements.
   - Have students complete Job Sheets #1 through #3.

F. Give test.

G. Critique test and discuss in class.

H. Reteach and retest as necessary.

I. Complete appropriate section of competency profiles.

SUGGESTED ACTIVITIES

III. Unit references

A. Burke, Arthur E.; Dalzell, J. Ralph; and Townsend, Gilbert. *Architectural and Building Trades Dictionary.* Chicago: American Technical Society. 1955.

B. Hendrix, Laborn J. "Bud." *Commercial Carpentry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1979.

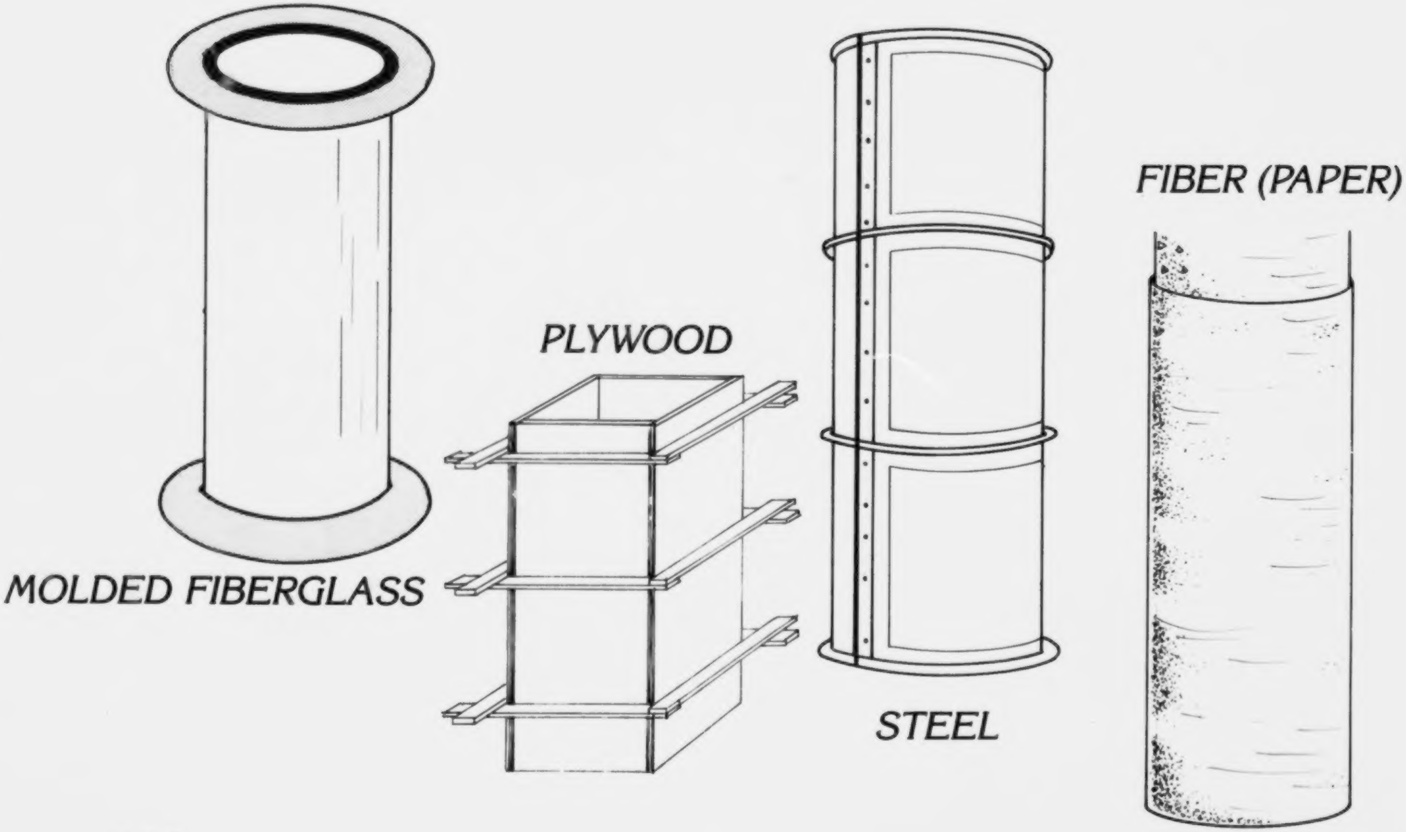
C. Hendrix, Laborn J. "Bud," and Patton, Bob. *Construction Craftsman's Curriculum.* Stillwater: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1978.

D. Hurd, M.K. *Formwork for Concrete* 4th Ed. Detroit, Michigan: American Concrete Institute, 1979.

E. Peufifoy, R.L. *Formwork for Concrete Structures.* New York: McGraw-Hill Book Company, 1964.

F. Smith, Ronald C. *Principles and Practices of Heavy Construction.* Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1970.

Column Form Material


MOLDED FIBERGLASS
PLYWOOD
STEEL
FIBER (PAPER)

VERTICAL PIERS AND COLUMNS
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Column clamp — Manufactured device placed around column form to strengthen form against pressure exerted by wet concrete

B. Yoke — Job-built device placed around column form to strengthen form against pressure exerted by wet concrete

C. Sheathing — Wide boards, plywood, or metal that make up the face of a form

D. Capital — Enlarged area at the top of a column

E. Pier — Support for an arch or a supporting section of wall between two openings

F. Column — Vertical shaft designed to support the structure above

G. Staves — Vertical sheathing in a circular column form

H. Strongback — Temporary brace attached to back of forms to help support them

I. Template — Gauge used as a pattern for copying or making identical parts

J. Flutes — Strips that form channels or grooves; used to decorate columns, especially in classical architecture

K. Wedge — Tapered piece of wood or metal

L. Column steel — Reinforcing rod shaped in round coils (like a spring) and tied to vertical steel

M. Strap wrench — Wrench used to tighten and hold band steel until it is secured

II. Factors that influence column form design

A. Temperature

B. Size and type of column

C. Rate of placing

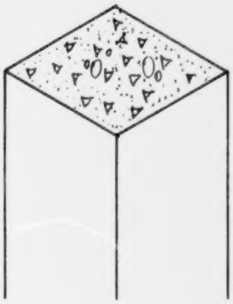
D. Cost

INFORMATION SHEET

III. Column Shapes (Figures 1-12)

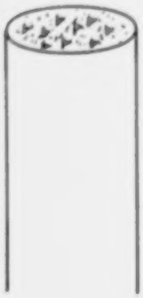
A. Square

FIGURE 1



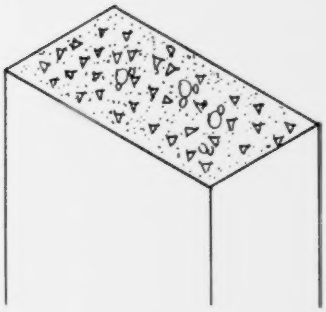
B. Round

FIGURE 2



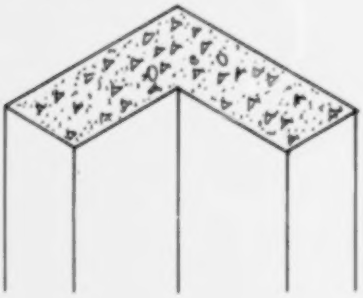
C. Rectangular

FIGURE 3



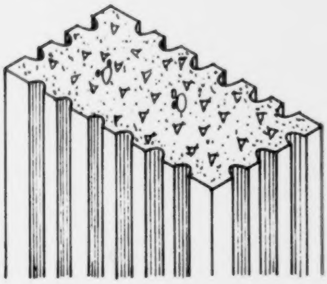
D. L-shaped

FIGURE 4



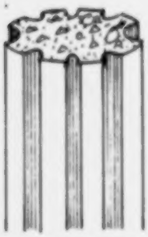
E. Rectangular-fluted

FIGURE 5



F. Round fluted

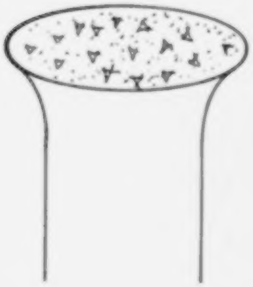
FIGURE 6



INFORMATION SHEET

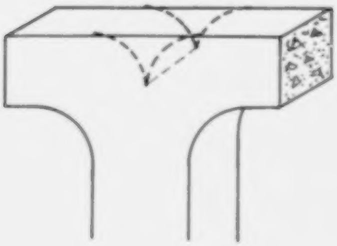
G. Round-capitaled

FIGURE 7



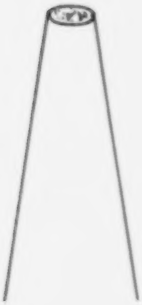
H. T-shaped or Y-shaped

FIGURE 8



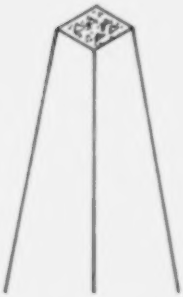
I. Round-tapered

FIGURE 9



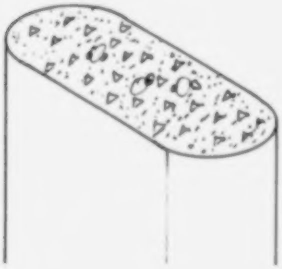
J. Square-or diamond-tapered

FIGURE 10



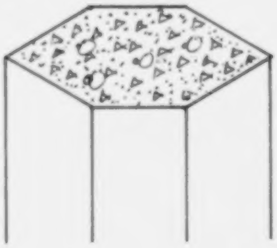
K. Obround

FIGURE 11



L. Hexagonal

FIGURE 12



INFORMATION SHEET

IV. Common types of materials used for column forms

A. Plywood

B. Solid wood

C. Metal

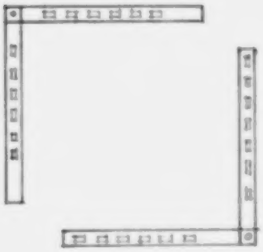
D. Fiber (paper)

E. Molded fiberglass

V. Types of clamps and yokes used on column forms (Figures 13-20)

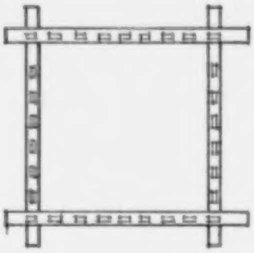
A. Hinged, double bar clamp

FIGURE 13



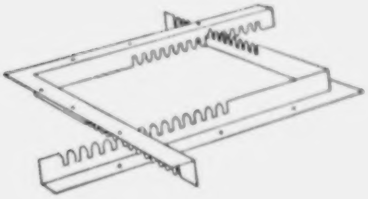
B. Single bar clamp

FIGURE 14



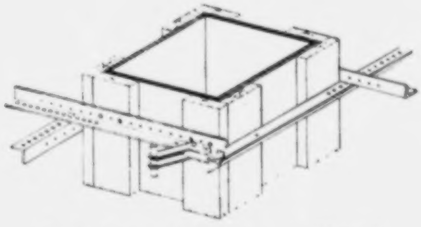
C. Light-duty clamp

FIGURE 15



D. Lockfast column clamp

FIGURE 16

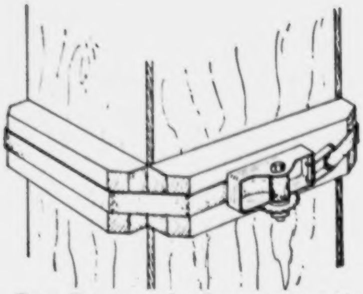


From *Formwork for Concrete*. Used by permission of the American Concrete Institute.

INFORMATION SHEET

E. Metal strap and sealing device

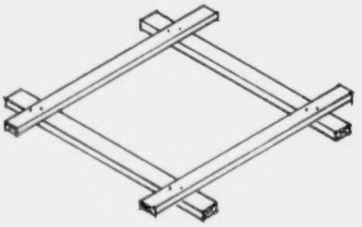
FIGURE 17



From *Formwork for Concrete*. Used by permission of the American Concrete Institute.

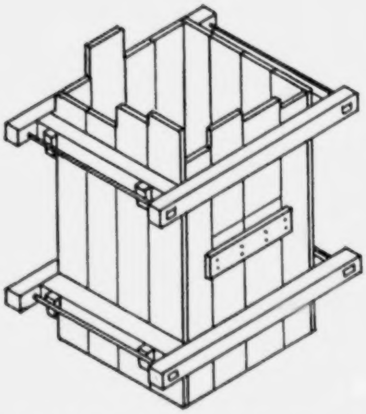
F. Wood yoke

FIGURE 18



G. Wood-and-bolt yoke

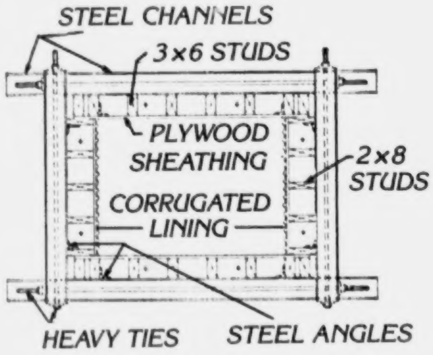
FIGURE 19



From *Formwork for Concrete*. Used by permission of the American Concrete Institute.

H. Steel channel and tie bolts (all thread)

FIGURE 20


STEEL CHANNELS
3×6 STUDS
PLYWOOD SHEATHING
2×8 STUDS
CORRUGATED LINING
HEAVY TIES
STEEL ANGLES

From *Formwork for Concrete*. Used by permission of the American Concrete Institute.

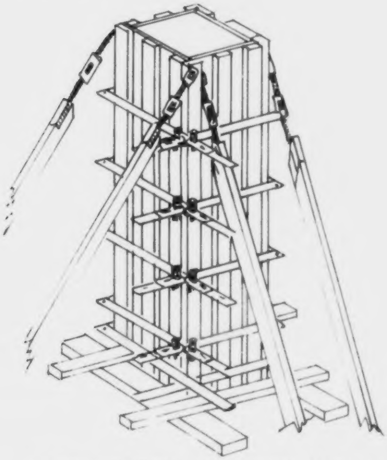
INFORMATION SHEET

VI. Methods of column form construction (Figures 21-24)

A. Job-built (build-in-place)

EXAMPLE:

FIGURE 21

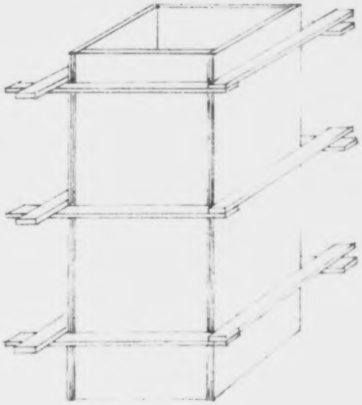


From *Formwork for Concrete*. Used by permission of the American Concrete Institute.

B. Prefabricated (built on job or in shop)

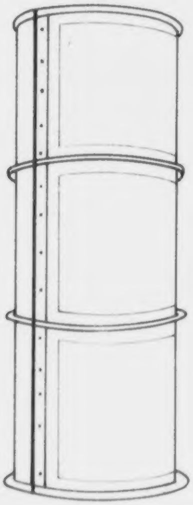
EXAMPLE:

FIGURE 22



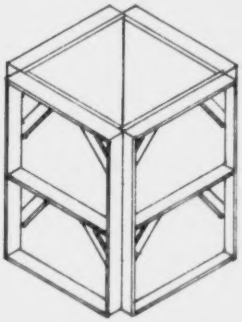
C. Manufactured metal forms

FIGURE 23



D. Combination wood and metal

FIGURE 24



VERTICAL PIERS AND COLUMNS
UNIT VI

JOB SHEET #1 — CONSTRUCT FORMS FOR A SQUARE COLUMN

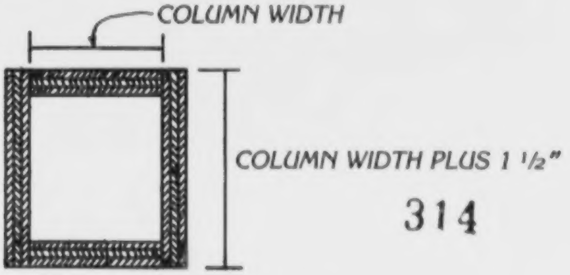
I. Equipment and materials

- A. Hammer
- B. Handsaw
- C. Power handsaw and extension cord
- D. String line
- E. Electric drill motor and drills
- F. Hand level, 30"
- G. Framing square
- H. Chalk line
- I. Folding rule or steel tape
- J. Pry bar
- K. Eye protection
- L. Sheathing plywood
- M. 2×4s for studs and template
- N. Appropriate column clamps
- O. Form oil and mop, brush, or sprayer
- P. 6d duplex, 16d duplex, and concrete nails or powder-actuated tool

II. Procedure

- A. Determine size of column
- B. Put on eye protection
- C. Cut column sides to size (Figure 25)

FIGURE 25



JOB SHEET #1

D. Cut column studs

(NOTE: Studs will be the same length as the column side.)

E. Assemble column sides (Figures 26 and 27)

FIGURE 26

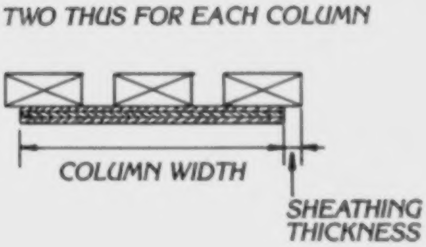
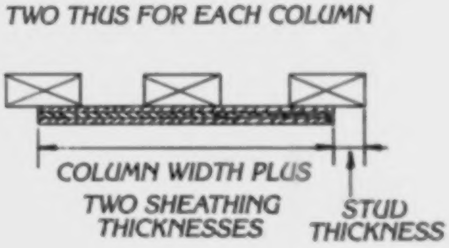

TWO THUS FOR EACH COLUMN
COLUMN WIDTH
SHEATHING THICKNESS

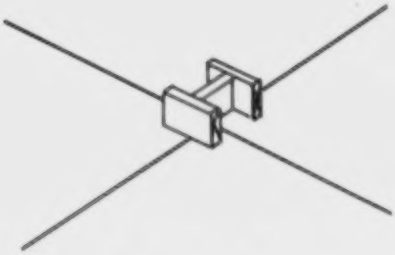
FIGURE 27


TWO THUS FOR EACH COLUMN
COLUMN WIDTH PLUS TWO SHEATHING THICKNESSES
STUD THICKNESS

F. Lay out column center lines (Figure 28)

(NOTE: Extend lines so they will show on outside of column forms and template.)

FIGURE 28



G. Construct template for base of column

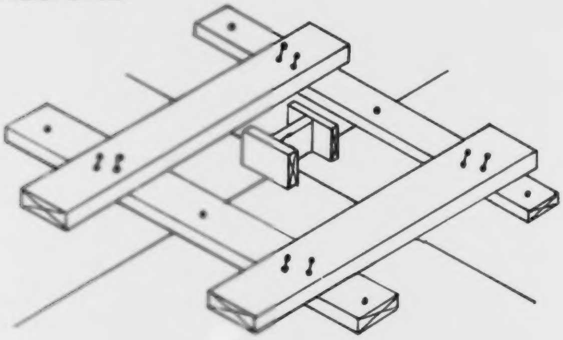
(NOTE: Template should be the same size as the outside of the column.)

JOB SHEET #1

H. Use concrete nails or powder-actuated fastener to nail template to floor (Figure 29)

> **CAUTION**
>
> Use powder-actuated fastener only if certified in its use. Follow manufacturer's instructions and safety precautions before loading or operation.

FIGURE 29



I. Refer to Table 1 to determine column clamp spacing

TABLE 1: Column Clamp Spacing

0' 0"		
	Clamp #1	6"
Height of Column	" #2	24"
	" #3	24"
	" #4	24"
8' 0"	" #5	18"
	" #6	18"
10' 0"	" #7	18"
12' 0"	" #8	15"
	" #9	15"
14' 0"	" #10	12"
	" #11	12"
16' 0"	" #12	12"
	" #13	12"
18' 0"	" #14	9"
	" #15	9"
	" #16	9"
20' 0"		3"

JOB SHEET #1

J. Lay out column clamp spacing on form sides

(NOTE: All steel must be completely in place and forms should be covered with form oil.)

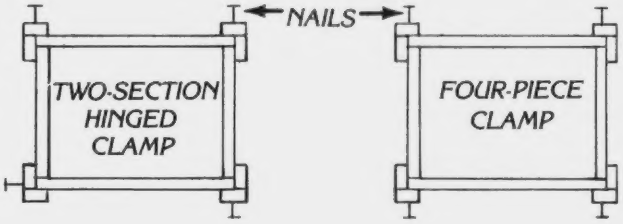
K. Stand opposing column sides in template and nail corner studs with duplex nails

L. Stand the other two sides in template and nail as in step K

M. Drive 16d duplex nail at each column clamp spacing mark (Figure 30)

(NOTE: These nails serve to support the clamps during installation. Check the type of clamp being used for side locations of nails.)

FIGURE 30



N. Lay sections of column clamps on nails and secure together

O. Install braces for columns

1. Nail braces to two sides of column near top of column
2. Nail block in position to floor so that lower end of brace can be nailed to block

P. Plumb column in both directions, and then nail bracing to blocks on floor

(NOTE: When several columns are set in a straight line, alignment is made by running a pair of stringers at the top of the columns from one column to the next. One brace is needed to plumb the column on the opposite side.)

Q. Recheck work for plumb and accuracy

R. Clean work area and return equipment and materials to proper storage

VERTICAL PIERS AND COLUMNS
UNIT VI

JOB SHEET #2 — SET A ROUND COLUMN (FIBERBOARD TUBE)

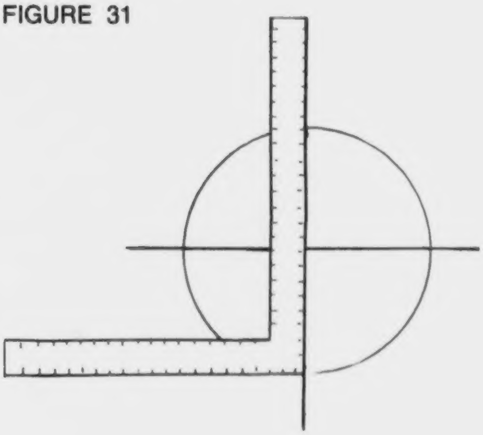
I. Equipment and materials

- A. Power handsaw and extension cord
- B. Handsaw
- C. Claw hammer
- D. Folding rule or steel tape
- E. Framing square
- F. Hand level, 30"
- G. Plumb bob
- H. Fiberboard tube, 24"×16'
- I. 2×4s for braces and templates
- J. 16d, and concrete nails or powder-actuated fastener
- K. Eye protection

II. Procedure

- A. Lay out column (Figure 31)

FIGURE 31



JOB SHEET #2

1. Establish center line

2. Mark center lines on floor using a framing square

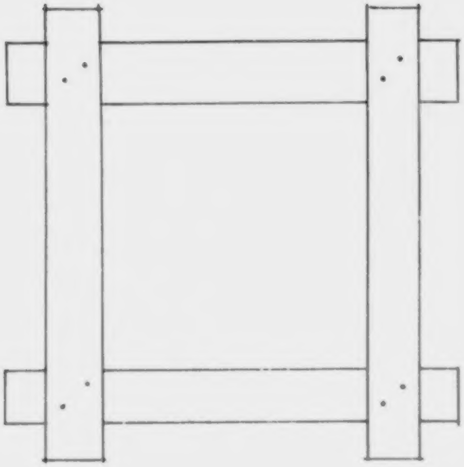
3. Mark center lines on column form at top and bottom

B. Prepare form for setting

1. Put on eye protection

2. Cut 2×4s and build template (Figure 32)

FIGURE 32



3. Nail templates together and mark center lines on the one that will be used at the bottom

   (NOTE: The number of templates depends on the size and height of the form.)

C. Set form

(NOTE: A scaffold will have to be set up beside the column location in order to lift the form over the reinforcing steel. See Figure 33 on next page.)

1. Lift form up and over steel, and carefully work it down to the floor (Figure 33)

2. Slip templates over form; toenail one at top and one at bottom of form

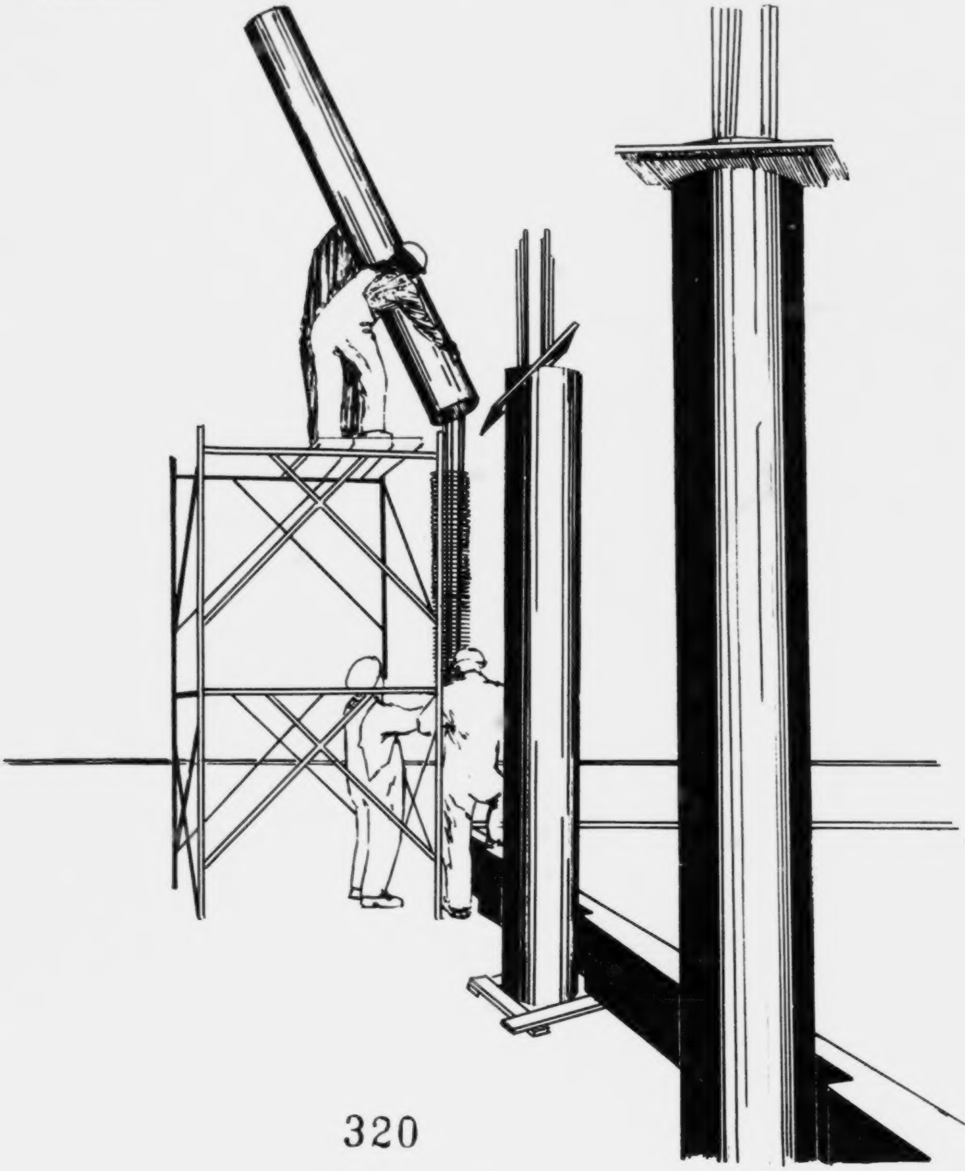
JOB SHEET #2

3. Line up center marks on bottom template with marks on floor; nail bottom template to floor with concrete nails or powder-actuated fastener

CAUTION

Use powder-actuated fastener only if certified in its use. Strictly follow manufacturer's instructions and safety precautions before loading or operating.

FIGURE 33

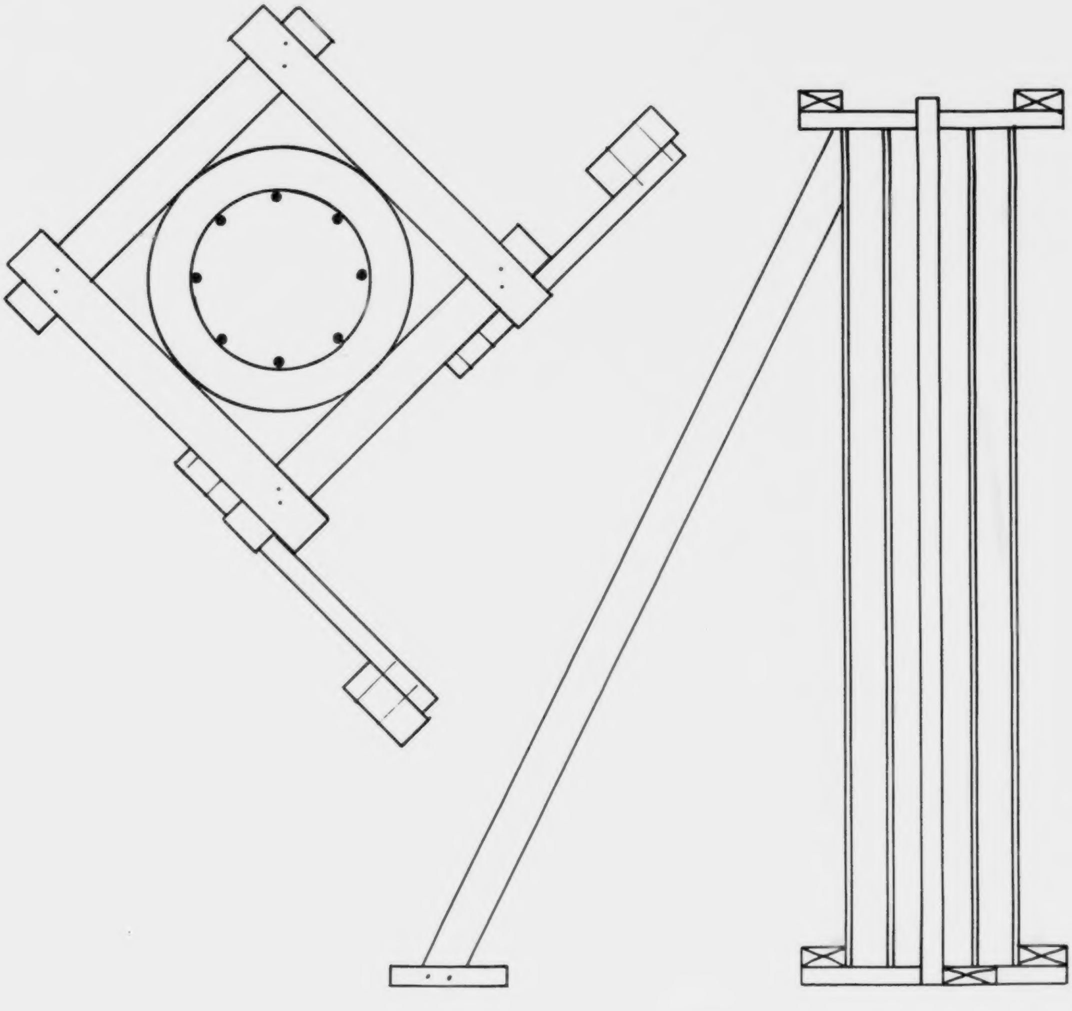


JOB SHEET #2

D. Plumb and brace form (Figure 34)

(NOTE: Two braces will be necessary in order to brace in two different directions.)

FIGURE 34



1. Brace to top template

2. Nail top of brace to stud

JOB SHEET #2

    3. Plumb column in both directions using plumb bob
    4. Nail brace to 2×4s that have been nailed to floor

E. Recheck work for plumb and accuracy

F. Clean work area and return equipment and materials to proper storage

VERTICAL PIERS AND COLUMNS
UNIT VI

JOB SHEET #3 — CONSTRUCT FORMS FOR A ROUND FLUTED COLUMN

I. Equipment and materials

- A. Power handsaw and extension cord
- B. Handsaw
- C. Claw hammer
- D. Folding rule or steel tape
- E. Hand level
- F. 100-foot tape
- G. Chalk line
- H. Transit
- I. Band saw or saber saw
- J. Drill motor and drills
- K. String line
- L. Strap wrench
- M. 1×2s for staves
- N. ³/₄" plywood segments
- O. 2×6s for studs
- P. 2×4 setting template
- Q. Steel strapping
- R. Half-round wood (flutes)
- S. Nonstaining form oil
- T. Angle iron
- U. Screws
- V. Bolts

JOB SHEET #3

W. Column clamps

X. Fasteners

1. 2d and 6d finish

2. 6d and 16d duplex

3. Concrete nails or powder-actuated fasteners

Y. Eye protection

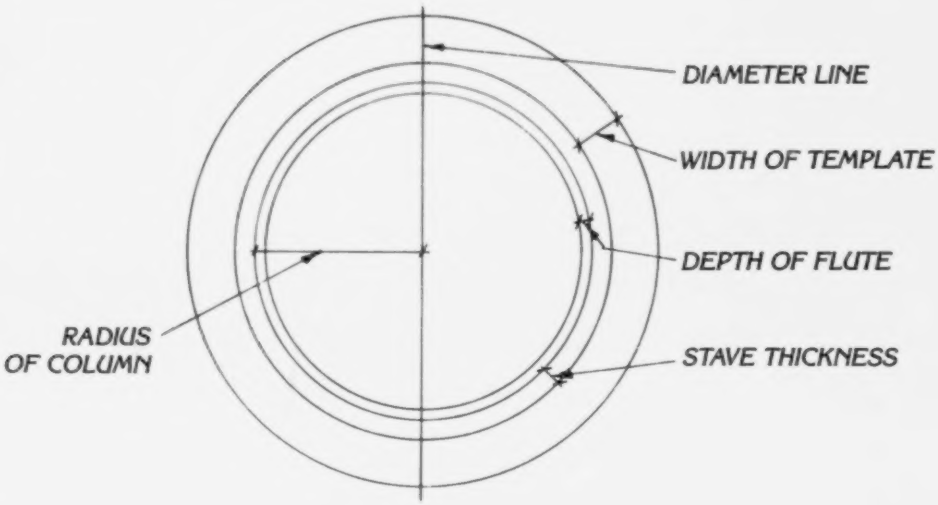
II. Procedure

A. Build forms

1. Lay out full-size pattern on floor or on a piece of plywood (Figure 35)

(NOTE: The diameter line will be the line on which the two halves of the form join. Place a stud at each end of the half form.)

FIGURE 35

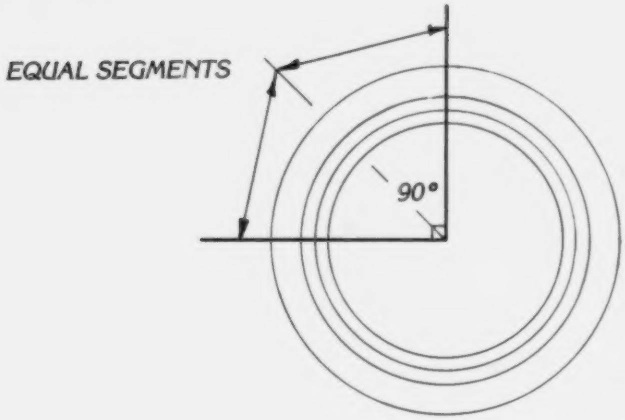

DIAMETER LINE
WIDTH OF TEMPLATE
DEPTH OF FLUTE
STAVE THICKNESS
RADIUS OF COLUMN

JOB SHEET #3

2. Divide quarter section of circle into equal segments (Figure 36)

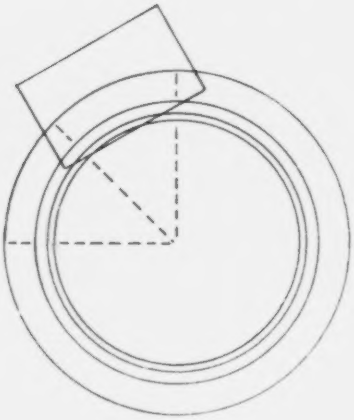
   (NOTE: The length of the segments is determined by the width and grain of the material used. The grain of the material should be as near parallel to the form surface as possible.)

FIGURE 36



3. Lay out template material on drawing and lay out segmental pattern (Figure 37)

FIGURE 37

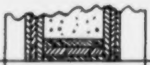


JOB SHEET #3

4. Determine number of segments needed

   (NOTE: Check column-clamp spacing schedule for segmental ring spacing in Table 2. Using the 8-foot column height as an example, there would be five segmental templates needed. Labor can be saved by using steel strapping at intermediate locations.)

TABLE 2: Column Clamp Spacing

0' 0"		
	Clamp #1	6"
Height of Column	" #2	24"
	" #3	24"
	" #4	24"
8' 0"	" #5	18"
	" #6	18"
10' 0"	" #7	18"
12' 0"	" #8	15"
	" #9	15"
14' 0"	" #10	12"
	" #11	12"
16' 0"	" #12	12"
	" #13	12"
18' 0"	" #14	9"
	" #15	9"
	" #16	9"
20' 0"		3"

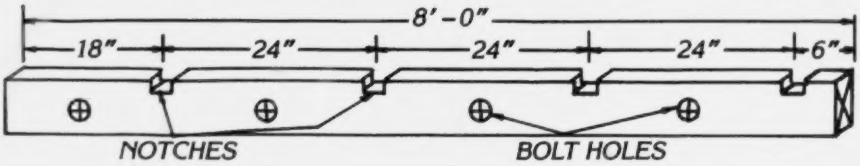
5. Put on eye protection

6. Cut required number of segments, marking the first segment "template," and using it for layout of remaining segments

7. Cut studs to length; notch and drill bolt holes (Figure 38)

   (NOTE: Notches should be placed at clamp spacing as determined from the schedule in Table 2. Bolt spacing should be at approximately 2-feet center to center. Be sure that all studs are notched and drilled in identical location.)

FIGURE 38: Clamp Spacing from Table 2

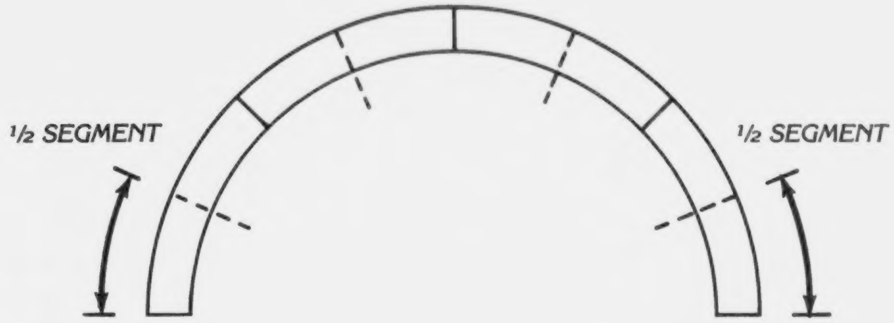


JOB SHEET #3

8. Nail segments together to form a half circle (Figure 39)

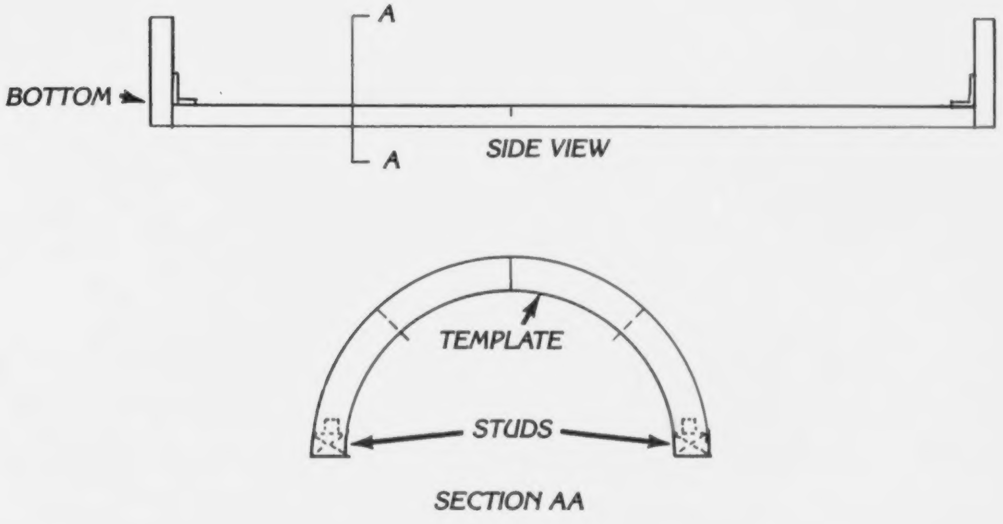
   (NOTE: Stagger the joints by starting the second layer using one-half of the segment.)

FIGURE 39


½ SEGMENT
½ SEGMENT

9. Attach segments to studs with light predrilled angle iron and screws (Figure 40)

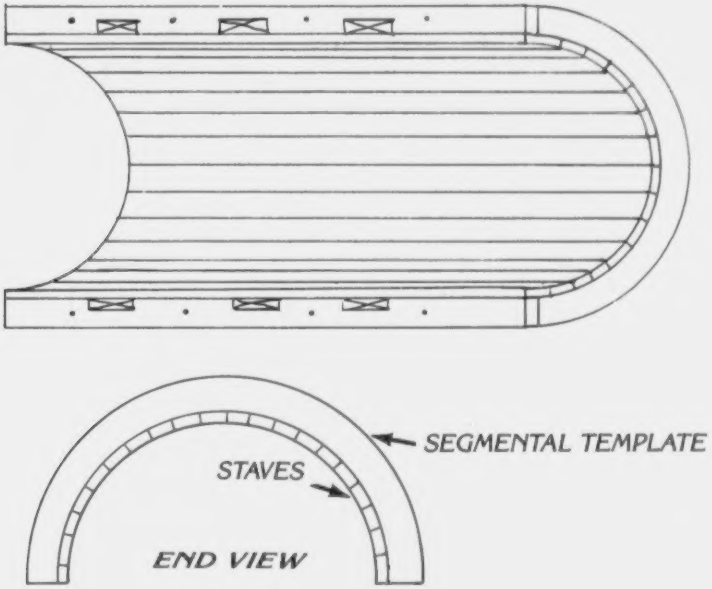
FIGURE 40


A
BOTTOM
A
SIDE VIEW
TEMPLATE
STUDS
SECTION AA

JOB SHEET #3

10. Nail staves to segments (Figure 41)

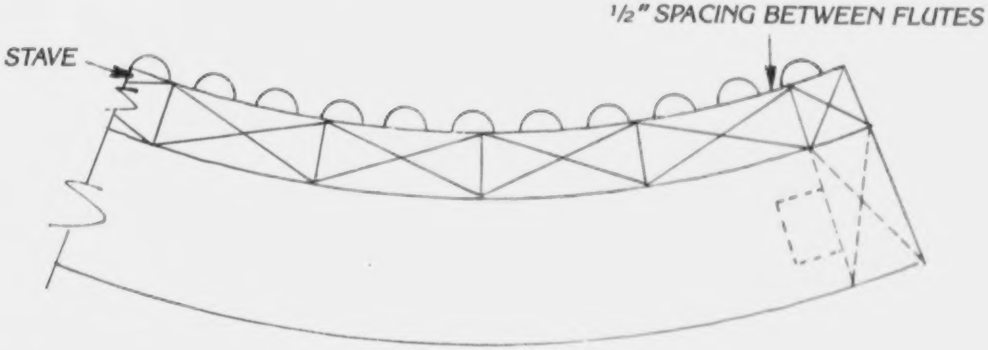
FIGURE 41


SEGMENTAL TEMPLATE
STAVES
END VIEW

11. Nail half-round wood to staves (Figure 42)

(NOTE: On the job, the size and spacing of the flutes are taken from the architects's plans.)

FIGURE 42


½" SPACING BETWEEN FLUTES
STAVE

JOB SHEET #3

12. Apply liberal coat of nonstaining form oil to form

    (NOTE: This column has an architectural surface. Be sure that the form oil is the nonstaining type.)

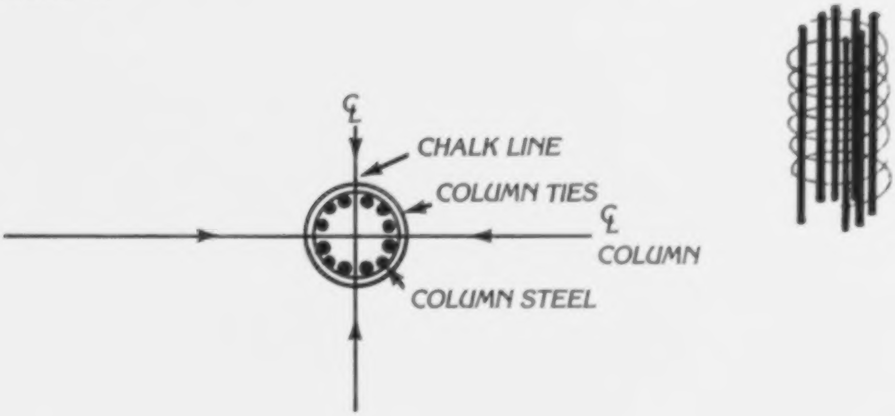
B. Set forms

(NOTE: Column steel should be set complete.)

1. Establish center line of column in both directions (Figure 43)

   (NOTE: Center lines may be established with a string line. Snap a chalk line in the column area.)

FIGURE 43



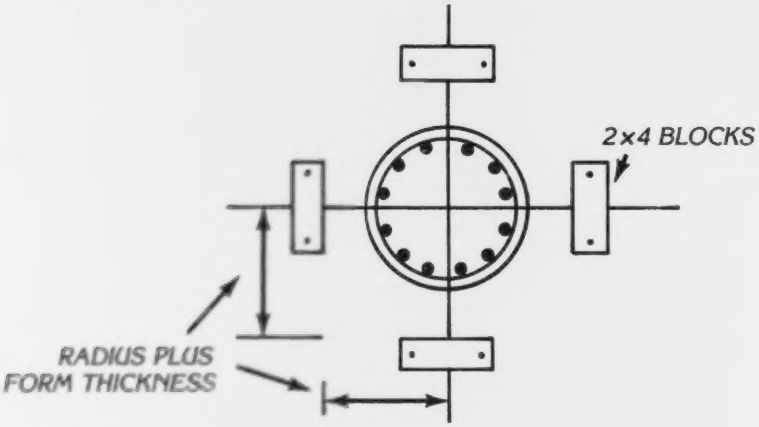
2. Locate outside of form and nail template blocks to floor with concrete nails or powder-actuated tool (See Figure 44.)

CAUTION

Use powder-actuated tool only if certified in its use. Strictly follow manufacturer's instructions and safety precautions before loading or operating tool.

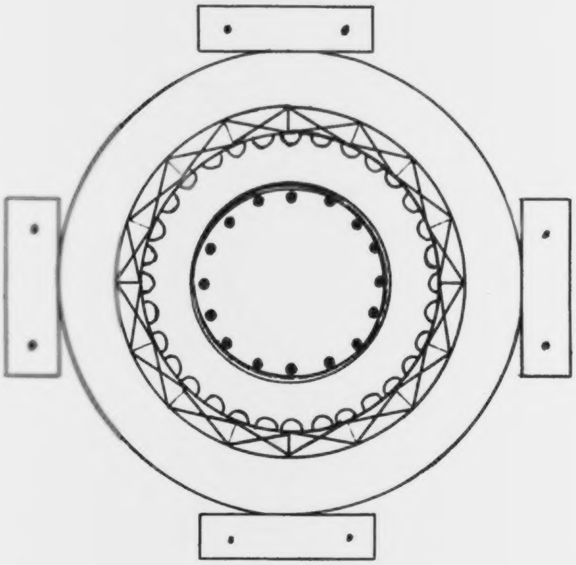
JOB SHEET #3

FIGURE 44


2×4 BLOCKS
RADIUS PLUS
FORM THICKNESS

3. Set form halves in position inside the floor templates (Figure 45)

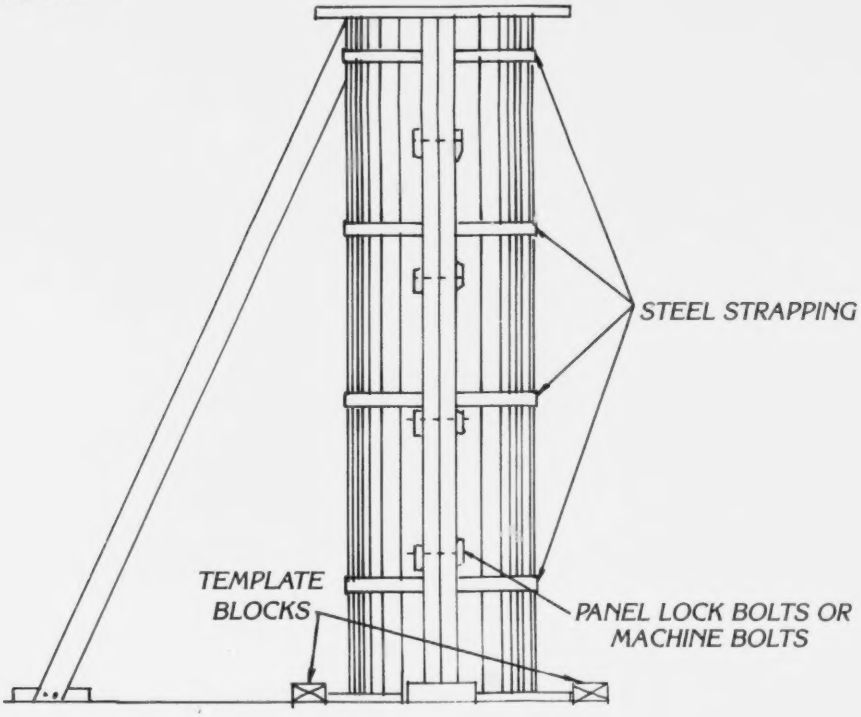
FIGURE 45



JOB SHEET #3

4. Bolt sections together (Figure 46)

FIGURE 46


STEEL STRAPPING
TEMPLATE BLOCKS
PANEL LOCK BOLTS OR MACHINE BOLTS

5. Place blocks under form and install steel strapping around template rings

   (NOTE: Form should be blocked up high enough to install strapping on bottom segmental template.)

6. Thread strapping through notches in studs and tighten, using strap wrench

7. Brace form plumb as shown in Figure 46

   (NOTE: Two braces placed at quarter sections of the form should be sufficient.)

C. Recheck work for plumb and accuracy

D. Clean work area and return equipment and materials to proper storage

VERTICAL PIERS AND COLUMNS
UNIT VI

TEST

NAME ______________________________ SCORE ______________

1. Match to their correct definitions terms associated with vertical piers and columns. Write the correct numbers in the blanks.

_____a. Manufactured device placed around column form to strengthen form against pressure exerted by wet concrete

_____b. Wide boards, plywood, or metal that make up the face of a form

_____c. Enlarged area at the top of a column

_____d. Job-built device placed around column form to strengthen form against pressure exerted by wet concrete

_____e. Support for an arch or a supporting section of wall between two openings

_____f. Vertical shaft designed to support structure above

_____g. Vertical sheathing in a circular column form

_____h. Temporary brace attached to back of forms to help support them

_____i. Gauge used as a pattern for copying or making identical parts

_____j. Strips that form channels or grooves; used to decorate columns, especially in classical architecture

_____k. Tapered piece of wood or metal

_____l. Reinforcing rod shaped in round coils (like a spring) and tied to the vertical steel

_____m. Wrench used to tighten and hold band steel until it is secured

1. Pier
2. Capital
3. Column
4. Staves
5. Sheathing
6. Yoke
7. Column clamp
8. Strongback
9. Template
10. Wedge
11. Strap wrench
12. Flutes
13. Column steel

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AGC

TEST

2. List factors that influence form design.

a. ______________________________

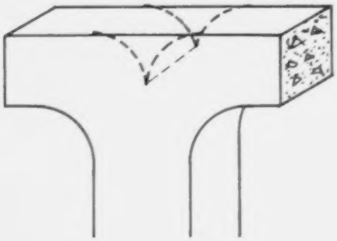
b. ______________________________

c. ______________________________

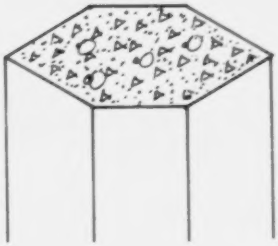
d. ______________________________

3. Identify the following column shapes. Write the correct names in the blanks.

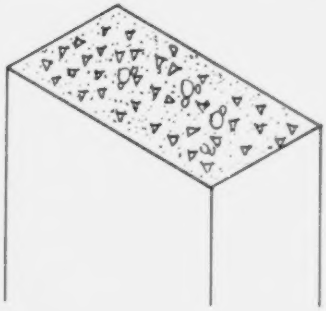
Square
Round
Rectangular
L-shaped
Rectangular-fluted
Round-fluted
Round-capitaled
T-shaped or Y-shaped
Round-tapered
Square- or diamond-tapered
Obround
Hexagonal



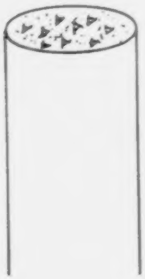
a. ______________________________



b. ______________________________

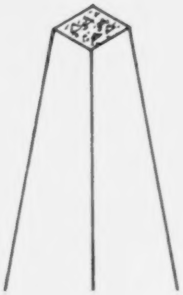


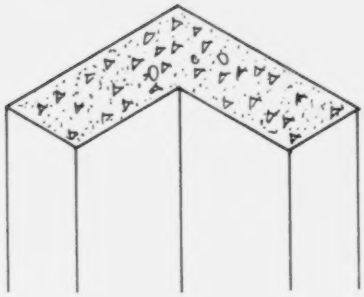
c. ______________________________



d. ______________________________

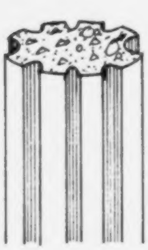
TEST

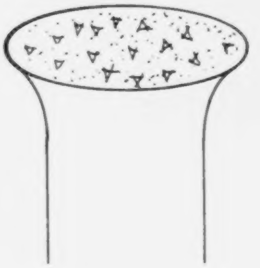




e. ______________________

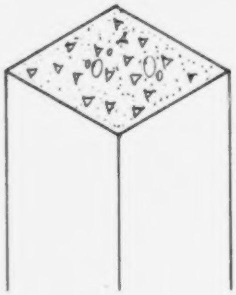
f. ______________________

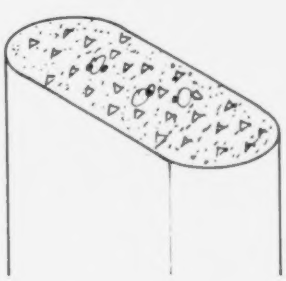




g. ______________________

h. ______________________

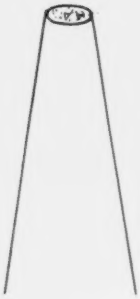


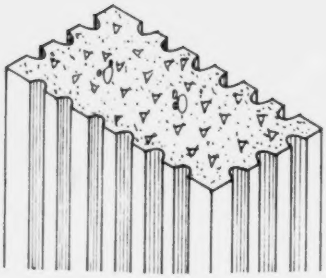


i. ______________________

j. ______________________

TEST





k. ______________________ l. ______________________

4. Name three common types of materials used for column forms.

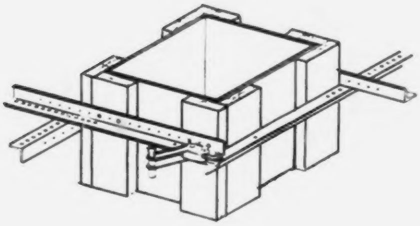
   a. ______________________

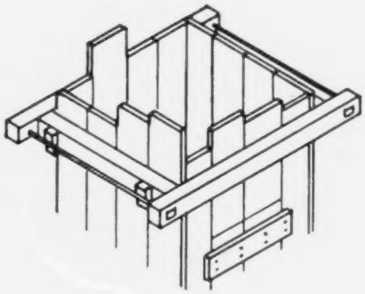
   b. ______________________

   c. ______________________

5. Identify the following types of clamps or yokes used on column forms.

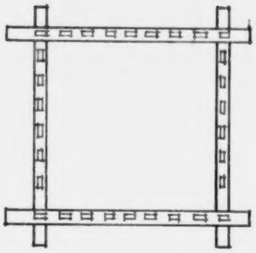
   Hinged double bar clamp
   Lockfast column clamp
   Wood and bolt yoke
   Light-duty clamp
   Single bar clamp
   Steel channel and tie bolts or all thread
   Wood yoke
   Metal strap and sealing device

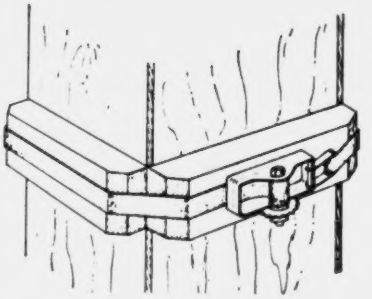




a. ______________________ b. ______________________

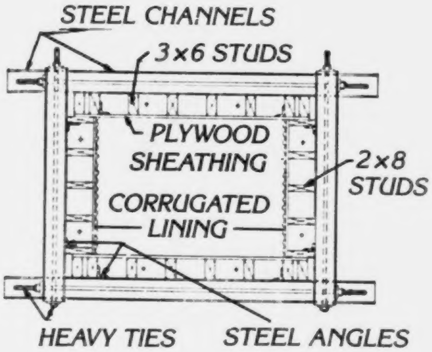
TEST

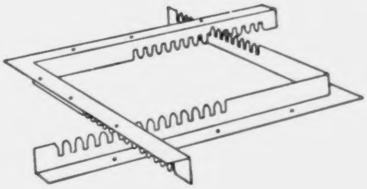




c. ______________________________

d. ______________________________

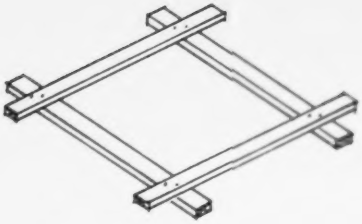

STEEL CHANNELS
3×6 STUDS
PLYWOOD SHEATHING
2×8 STUDS
CORRUGATED LINING
HEAVY TIES
STEEL ANGLES

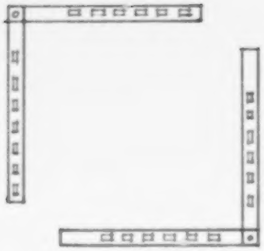


e. ______________________________

f. ______________________________

TEST





g. ______________________ h. ______________________

6. Name methods of column form construction.

   a. ______________________

   b. ______________________

   c. ______________________

   d. ______________________

(NOTE: Test question 7 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

7. Demonstrate ability to

   a. Construct forms for a square column.

   b. Set a round column form (fiberboard tube).

   c. Construct forms for a round fluted column.

VERTICAL PIERS AND COLUMNS
UNIT VI

ANSWERS TO TEST

1. a. 7
   b. 5
   c. 2
   d. 6
   e. 1
   f. 3
   g. 4
   h. 8
   i. 9
   j. 12
   k. 10
   l. 13
   m. 11

2. a. Temperature
   b. Size and type of column
   c. Rate of placing
   d. Cost

3. a. T-or Y-shaped
   b. Hexagonal
   c. Rectangular
   d. Round
   e. Square- or diamond-tapered
   f. L-shaped
   g. Round fluted
   h. Round capitaled
   i. Square
   j. Obround
   k. Round tapered
   l. Rectanglar-fluted

4. Answer should include any of the following

   a. Plywood
   b. Solid wood
   c. Metal
   d. Fiber
   e. Molded fiberglass

5. a. Lock-fast column clamp
   b. Wood-and-bolt yoke
   c. Single bar clamp
   d. Metal strap and sealing device
   e. Steel channel and tie bolt or all thread
   f. Light-duty clamp
   g. Wood yoke
   h. Hinged double bar clamp

6. a. Job-built
   b. Prefabricated
   c. Manufactured metal
   d. Combination wood and metal

7. Performance skills evaluated to the satisfaction of the instructor

HORIZONTAL BEAM FORMS
UNIT VII

UNIT OBJECTIVE

After completing this unit, the student should be able to construct different types of beam forms. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with horizontal beam forms.
2. Identify the parts of a beam form.
3. Name types of beams.
4. List types of materials used to construct beam forms.
5. Identify types of beam shores.
6. Demonstrate ability to
    a. Construct a spandrel beam form.
    b. Construct an interior beam form.
    c. Construct a post-tensioned inverted beam form.

HORIZONTAL BEAM FORMS
UNIT VII

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency masters

    1. TM #1 — Parts of a Beam Form

    2. TM #2 — Types of Beams

    3. TM #3 — Beam Without Intermediate Shoring

  D. Information sheet

  E. Job sheets

    1. Job Sheet #1 — Construct a Spandrel Beam Form

    2. Job Sheet #2 — Construct an Interior Beam Form

    3. Job Sheet #3 — Construct a Post-Tensioned Inverted Beam Form

  F. Test

  G. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Order or obtain materials to supplement unit.

    1. Equipment and materials for procedures outlined in the job sheets

    2. Latest edition of *Modern Carpentry*

    (NOTE: Order from The Goodheart-Willcox Company, 123 West Taft Drive, South Holland, Illinois 60473.)

    3. Transparencies and competency profiles

    (NOTE: Transparencies and competency profiles for this manual are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E. Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

SUGGESTED ACTIVITIES

C. Introduce unit.

SUGGESTIONS:

- Stress the importance of good, solid forms.
- Explain the differences among horizontal beam forms, and explain the reasons for choosing one type of form over another for a specific job.
- Explain the different methods, techniques, and materials used by different contractors.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

1. Use Information Sheet, Section I to introduce terms and definitions associated with horizontal beam forms.

   SUGGESTIONS:

   - Show students examples of appropriate terms.
   - Explain that learning these terms and definitions will help the students communicate with others in the carpentry trade and will help them better understand the information in this unit.
   - Emphasize importance of safety when building forms.

2. Use Information Sheet, Section II to introduce students to the various parts of a beam form.

   SUGGESTIONS:

   - Use Transparency #1 to illustrate your discussion.
   - Have students examine and identify the parts of an actual beam form.

3. Use Information Sheet, Section III to discuss types of beams.

   SUGGESTIONS:

   - Use Transparency #2 to illustrate your discussion.
   - Take students on a tour of construction sites in the community so that they may see examples of each type of beam.
   - Explain the advantages and disadvantages of the various types of beams.

SUGGESTED ACTIVITIES

4. Use Information Sheet, Section IV to discuss the types of materials used to construct beam forms.

5. Use Information Sheet, Section V to introduce the students to types of beam shores.

   SUGGESTIONS:

   - Use Transparency #3 to illustrate your discussion.
   - Take the students on a tour of construction sites in the community so that they may see examples of the types of beam shores used in commercial carpentry.

H. Give test.

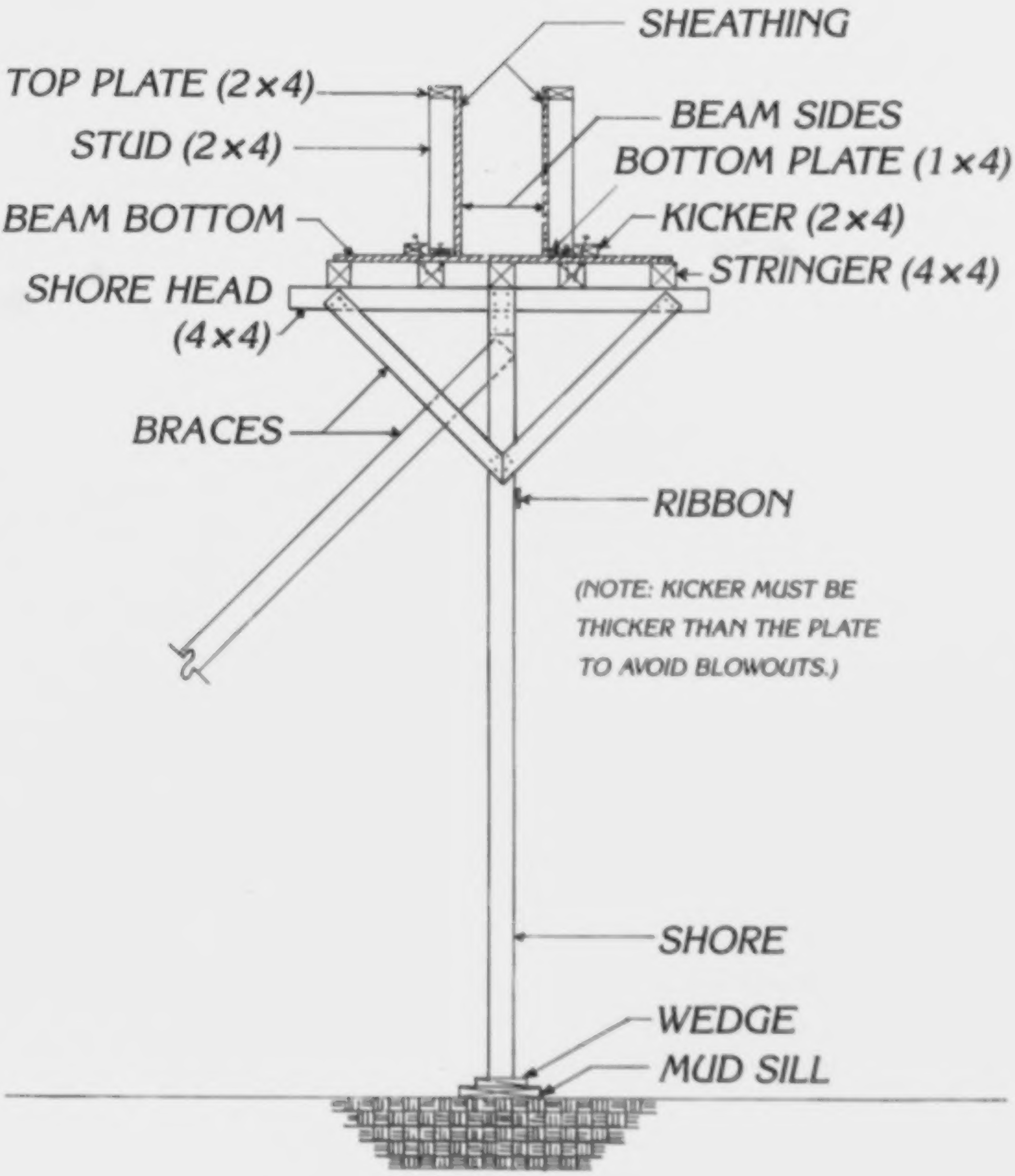
I. Critique test and discuss in class.

J. Reteach and retest if necessary.

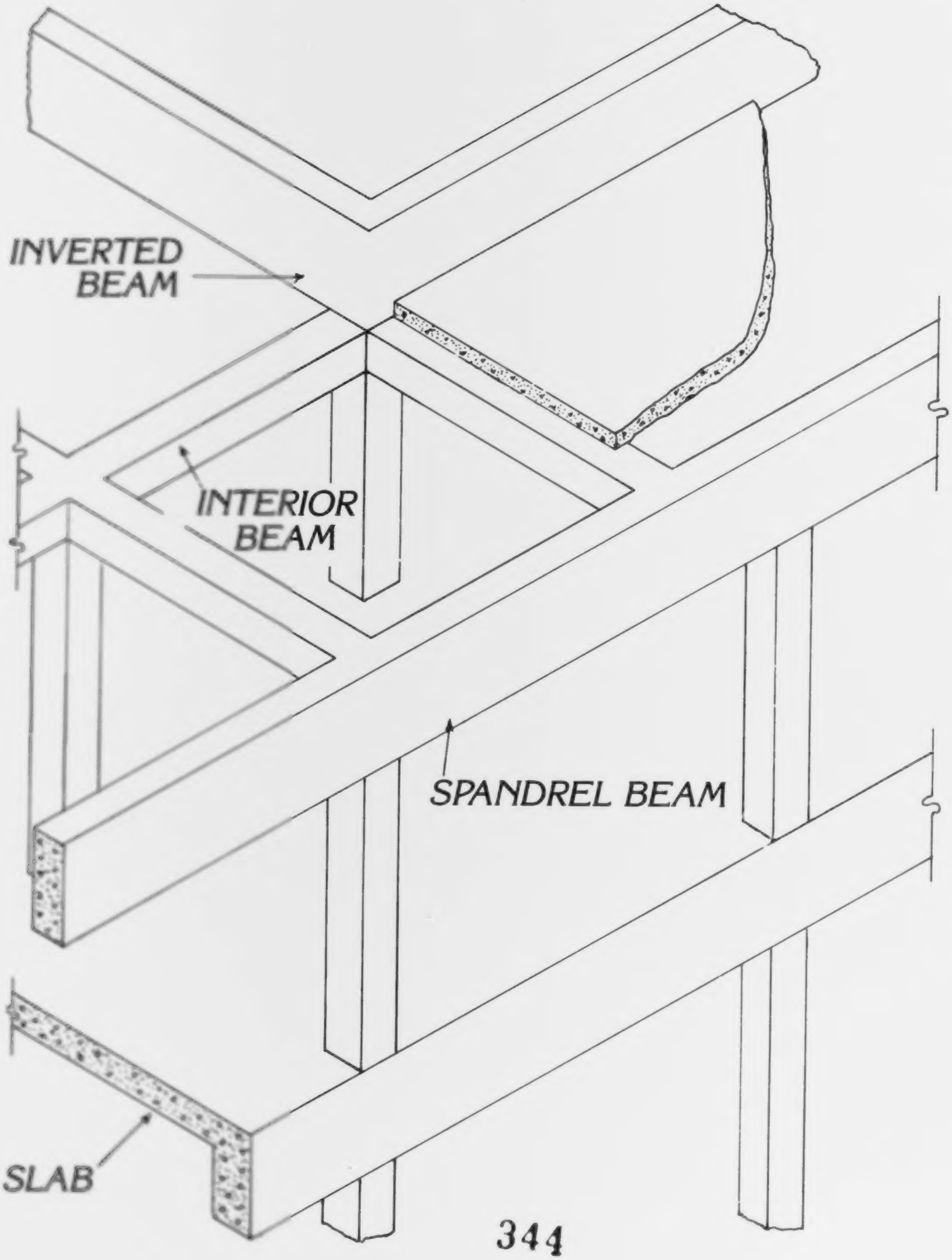
K. Complete appropriate section of the competency profiles.

III. Unit reference — Hendrix, Laborn J., "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

Parts of a Beam Form

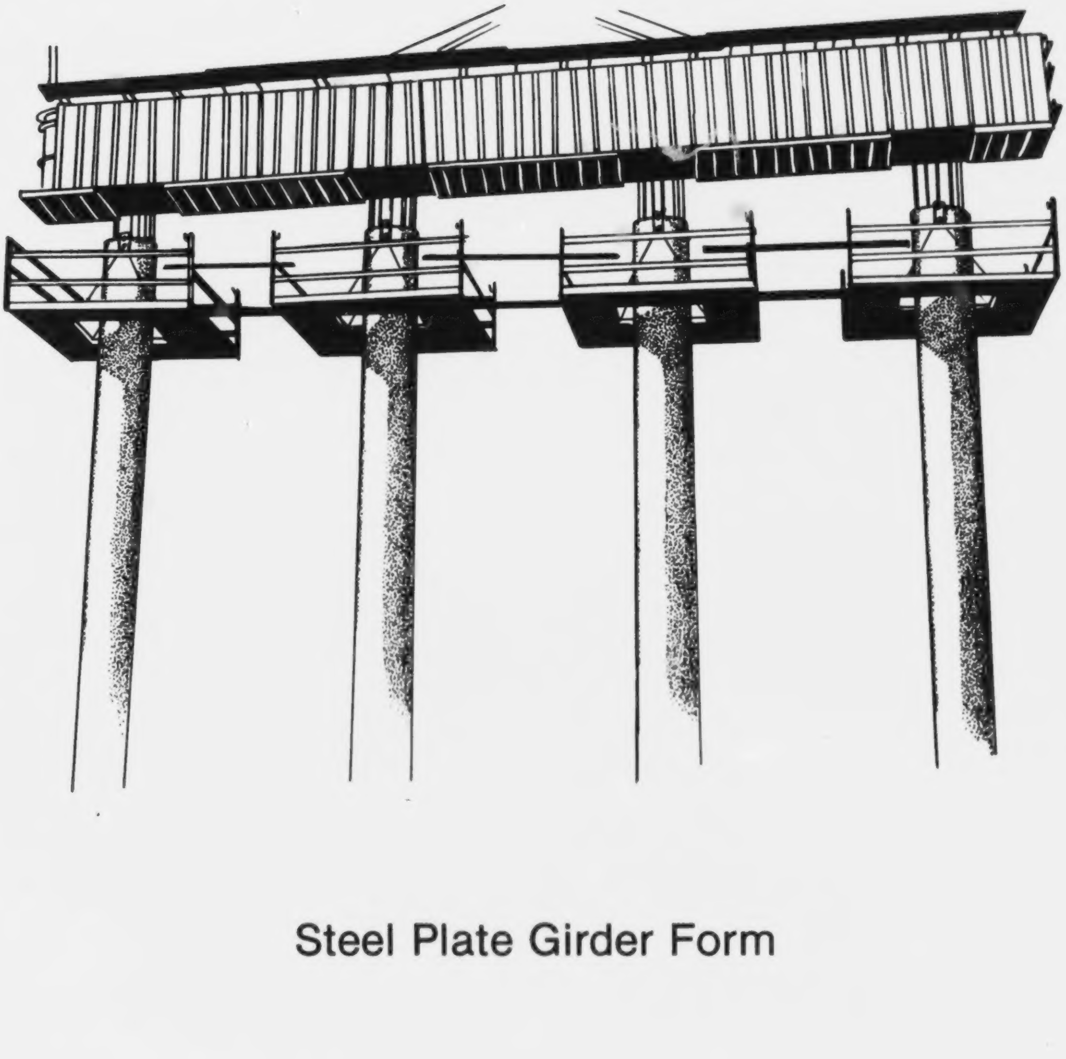

SHEATHING
TOP PLATE (2×4)
BEAM SIDES
STUD (2×4)
BOTTOM PLATE (1×4)
BEAM BOTTOM
KICKER (2×4)
STRINGER (4×4)
SHORE HEAD (4×4)
BRACES
RIBBON
(NOTE: KICKER MUST BE THICKER THAN THE PLATE TO AVOID BLOWOUTS.)
SHORE
WEDGE
MUD SILL

Types of Beams


INVERTED BEAM
INTERIOR BEAM
SPANDREL BEAM
SLAB

CC - 375-A

Beam Without Intermediate Shoring



Steel Plate Girder Form

TM #3

HORIZONTAL BEAM FORMS
UNIT VII

INFORMATION SHEET

I. Terms and definitions

A. Brace — Piece of wood or other material that directs, resists, or supports weight or pressure

B. Nail point tie — Form tie with one end bent 90 degrees and pointed

C. Scab — Piece of material nailed across a splice to strengthen it and hold it together

D. Spreader — Piece of wood used to hold sides of forms apart; is removed as concrete is poured or may be an integral part of a form tie

E. Cleat — Strip of wood or metal fastened across a form for temporary positioning or to replace a form tie

F. Shore — Prop placed against or beneath an object for support

G. Shore head — Horizontal timber placed across a shore and braced squarely

H. Beam bottom — That part of beam form that supports vertical pressure

I. Kicker — Piece of material used to resist horizontal pressure

J. Spandrel beam — Exterior or perimeter beam spanning two structures to support structure above

K. Stringer — Piece of heavy material placed across several shores; horizontal or inclined supporting member

L. Tendon — Single or multistrand of high-tensile wire or a rod used to stress concrete

M. Post tensioning — Method of prestressing reinforced concrete in which tendons are tensioned after the concrete has hardened

EXAMPLE: Post tensioning anchors for tendons attached to form

(NOTE: Concrete is cast around unstressed tendons enclosed in flexible metal or plastic ducts to prevent bond with concrete. After concrete hardens the tendons are stressed and anchored to the ends of the member, thus prestressing the concrete.)

INFORMATION SHEET

N. Mud sill — Horizontal timber laid directly on ground to support frame structure

O. Form oil — Paraffin oil or other manufactured product used on form to prevent adhesion of concrete to form

P. Ribbon — Horizontal board used to hold shores in alignment and to resist lateral movement

Q. Wedge — Tapered piece of wood or metal

R. Beam side — Stud frame and sheathing section that comprise vertical section of a beam form

S. Sill — Large piece of wood or other material laid flat on floor, and upon which scaffolds or shores are set

T. Tie holes — Holes that are exposed in concrete when form snap ties are removed

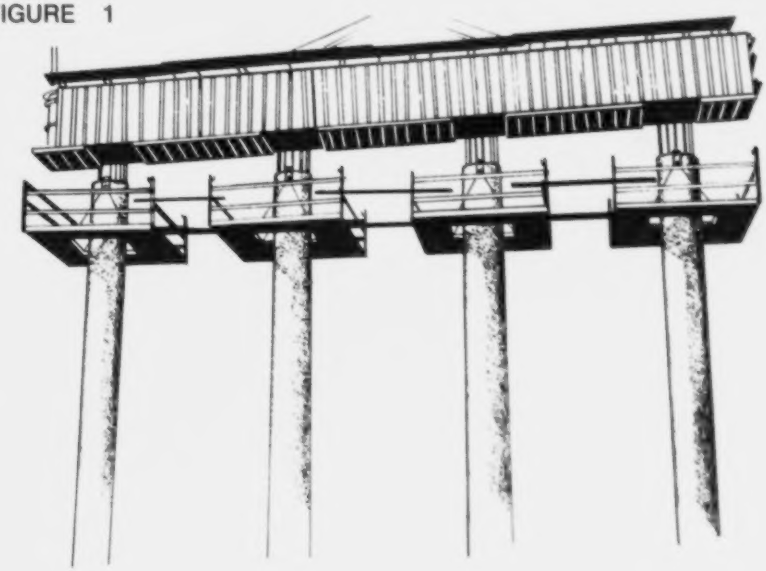
U. Waler — Horizontal brace used in form construction

V. Shore jack — Tool used to jack up some patented shores

W. Steel plate girder — Type of beam form that does not require intermediate shoring (Figure 1)

EXAMPLE:

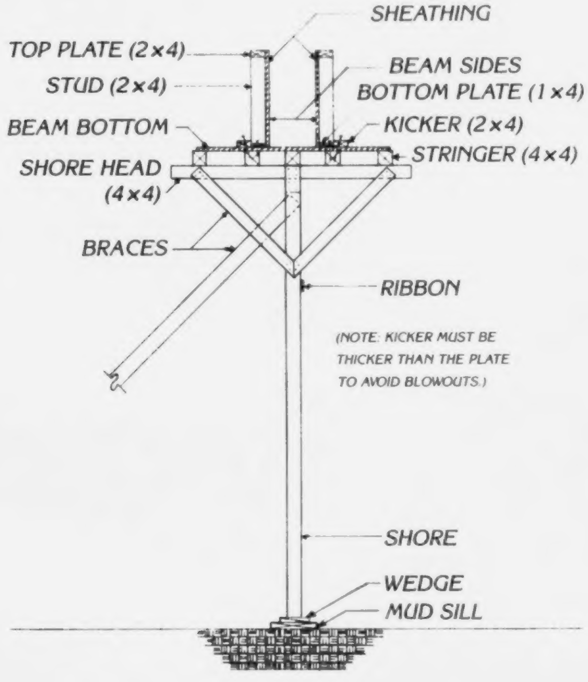
FIGURE 1



INFORMATION SHEET

II. Parts of a beam form (Figure 2)

FIGURE 2


SHEATHING
TOP PLATE (2×4)
STUD (2×4)
BEAM SIDES
BOTTOM PLATE (1×4)
BEAM BOTTOM
KICKER (2×4)
STRINGER (4×4)
SHORE HEAD (4×4)
BRACES
RIBBON
(NOTE: KICKER MUST BE THICKER THAN THE PLATE TO AVOID BLOWOUTS.)
SHORE
WEDGE
MUD SILL

III. Types of beams (Figure 3)

A. Spandrel

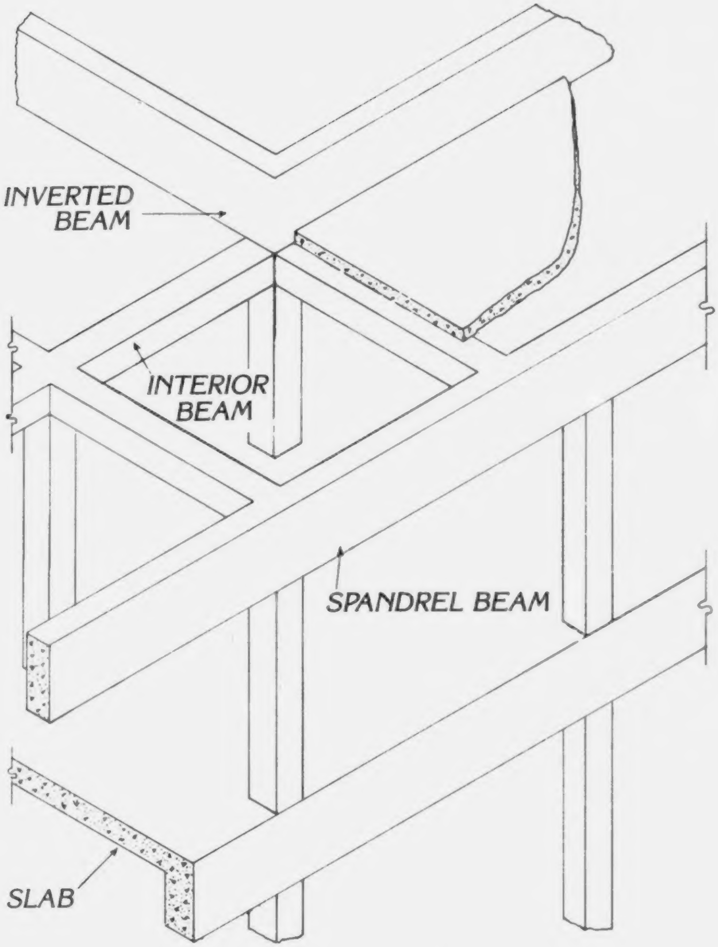
B. Interior

C. Inverted

INFORMATION SHEET

EXAMPLE:

FIGURE 3


INVERTED BEAM
INTERIOR BEAM
SPANDREL BEAM
SLAB

IV. Materials used to construct beam forms

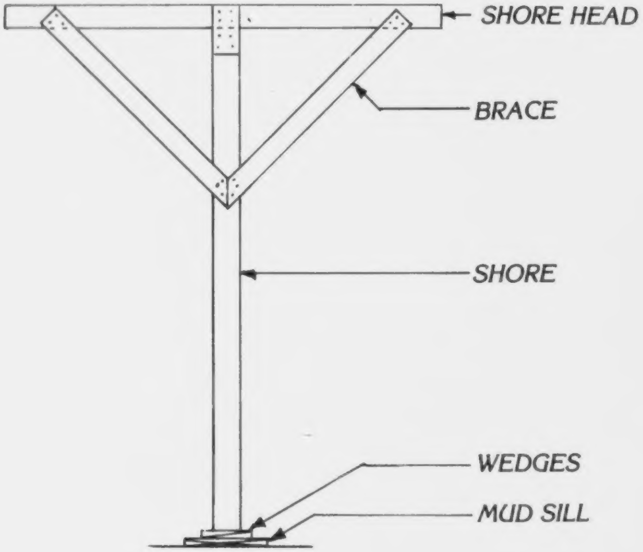
- A. Wood
- B. Metal
- C. Molded fiberglass
- D. Combination fiberglass and wood or metal

INFORMATION SHEET

V. Methods of shoring beams (Figures 4-9)

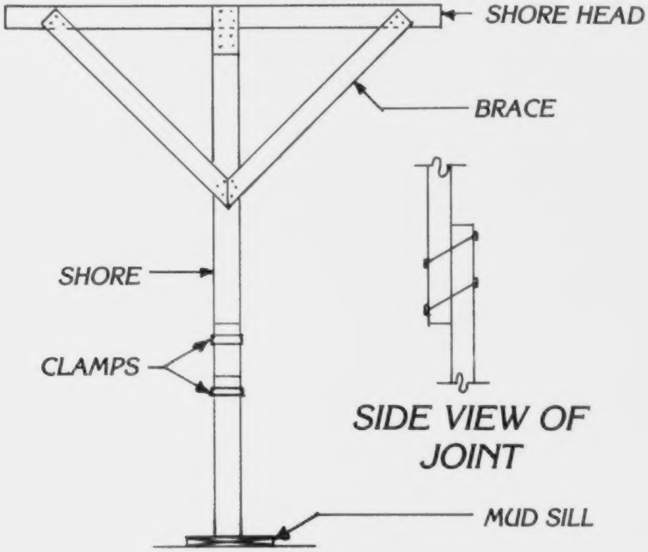
A. Wood "T" shore with wedges

FIGURE 4


SHORE HEAD
BRACE
SHORE
WEDGES
MUD SILL

B. Wood "T" shore with manufactured clamps

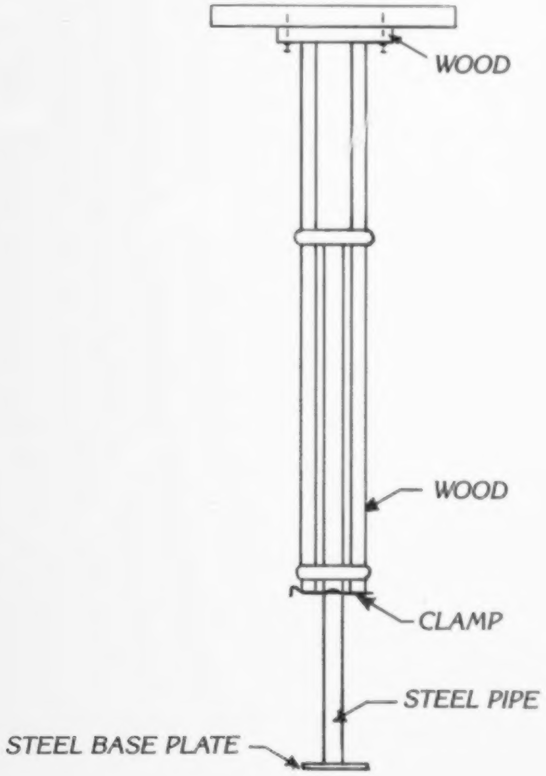
FIGURE 5


SHORE HEAD
BRACE
SHORE
CLAMPS
SIDE VIEW OF JOINT
MUD SILL

INFORMATION SHEET

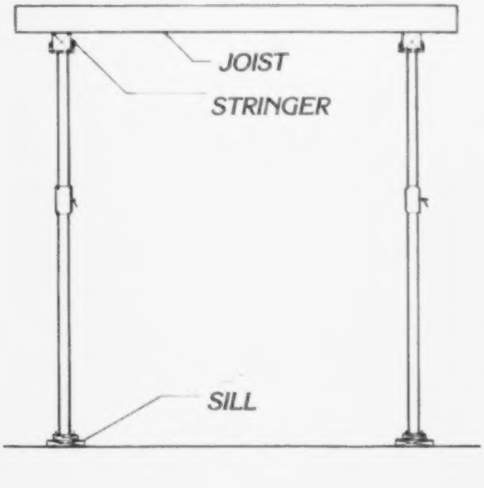
C. Patented wood and metal "T" shore

FIGURE 6


WOOD
WOOD
CLAMP
STEEL PIPE
STEEL BASE PLATE

D. Patented adjustable steel post

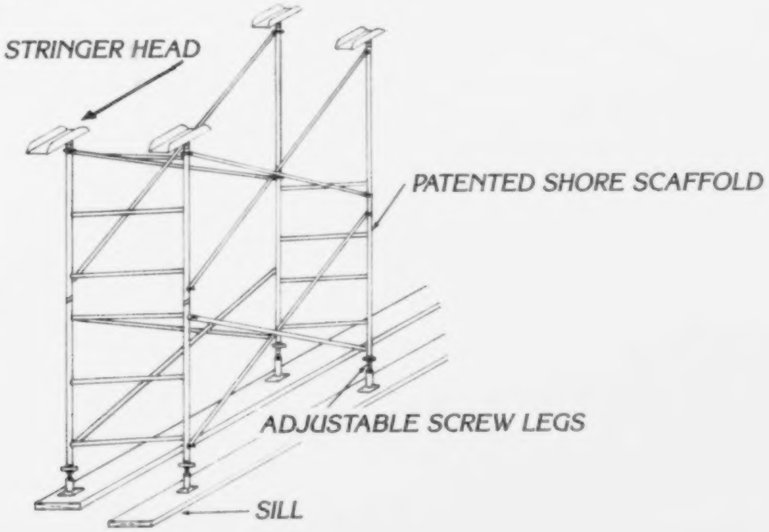
FIGURE


JOIST
STRINGER
SILL

INFORMATION SHEET

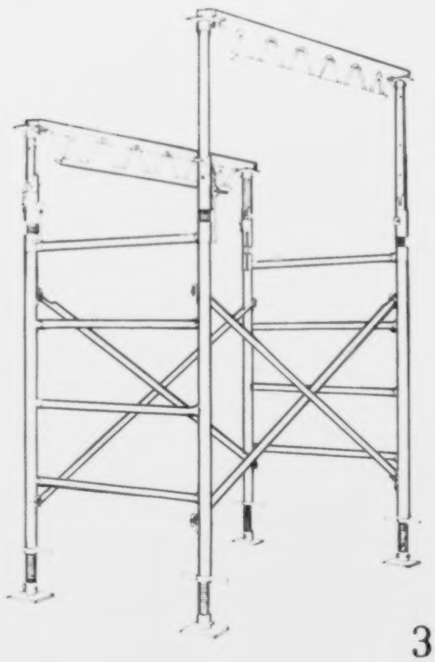
E. Patented tubular-steel, scaffold-type

FIGURE 8


STRINGER HEAD
PATENTED SHORE SCAFFOLD
ADJUSTABLE SCREW LEGS
SILL

F. Patented tubular-steel, scaffold-type with purlins and beams

FIGURE 9



HORIZONTAL BEAM FORMS
UNIT VII

JOB SHEET #1 — CONSTRUCT A SPANDREL BEAM FORM

I. Tools and materials

   A. Tools

      1. Claw hammer
      2. Handsaw
      3. Power handsaw and extension cord
      4. Plumb bob
      5. Thirty-inch hand level
      6. String line
      7. Electric drill motor, 1/4" or 3/8", and drills
      8. Folding rule or steel tape
      9. Framing square
      10. Chalkline
      11. Builder's level and rod

   B. Materials

      1. Nail point ties
      2. Plywood sheathing
      3. 2×4s for studs, upper plates, kickers, and walers
      4. 4×4s or larger for shores
      5. 4×4s or 4×6s for stringers
      6. 2×2s or larger for sills
      7. Patented shore clamps
      8. 1×4s for bottom plate, braces, and cleats
      9. Form ties
      10. 8d and 16d duplex nails and 6d and 8d box nails

JOB SHEET #1

II. Procedure

A. Determine beam size

(NOTE: On the job, this information will be secured from the structural plans and beam schedule.)

B. Fabricate beam sides

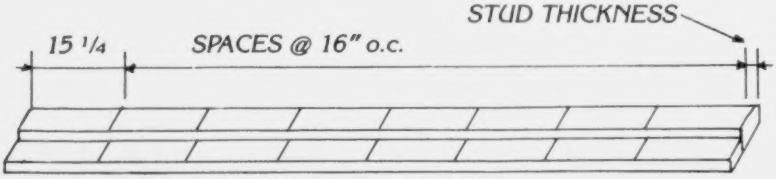
1. Cut plywood to proper width

2. Cut studs and plates to length

   (NOTE: Deduct thickness of top and bottom plates from beam side height to get stud length.)

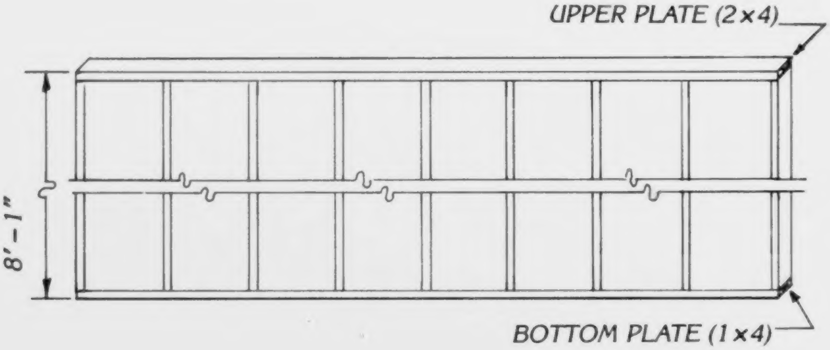
3. Lay out stud spacing on plates (Figure 10)

FIGURE 10


STUD THICKNESS
15 1/4
SPACES @ 16" o.c.

4. Nail studs to plate (Figures 11 and 12)

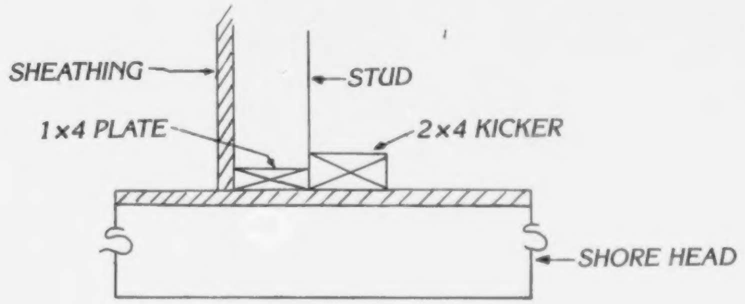
FIGURE 11


UPPER PLATE (2×4)
8'–1"
BOTTOM PLATE (1×4)

JOB SHEET #1

(NOTE: A one-inch plate is used on the bottom so the studs will bear against the kicker. See Figure 12.)

FIGURE 12


SHEATHING
STUD
1×4 PLATE
2×4 KICKER
SHORE HEAD

5. Nail sheathing to stud frame

   (NOTE: Sheathing should be flush with all four edges of stud frame.)

6. Build required number of beam sides following steps 1 to 5

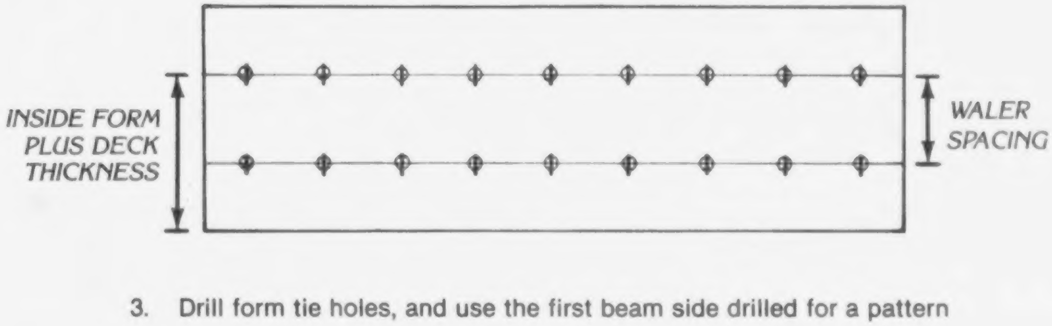
C. Drill form tie holes

1. Follow form manufacturer's recommendations or specifications for waler and tie spacing

2. Lay out and drill form tie holes

   (NOTE: Top row of ties should be the height of the inside form plus deck thickness. See Figure 13.)

FIGURE 13


INSIDE FORM PLUS DECK THICKNESS
WALER SPACING

3. Drill form tie holes, and use the first beam side drilled for a pattern

   (NOTE: The inside beam side will have only one row of tie holes.)

JOB SHEET #1

D. Build "T" shores

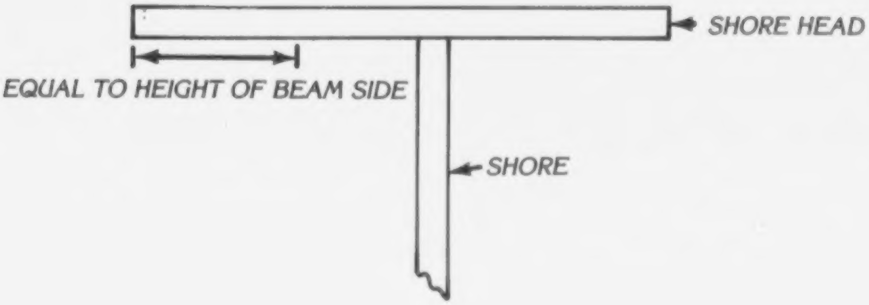
1. Cut 4×4s to length

   (NOTE: Shore pieces must be cut to have a minimum of a two-foot lap.)

2. Lay shore heads at end of shores and at a right angle to the shore (Figure 14)

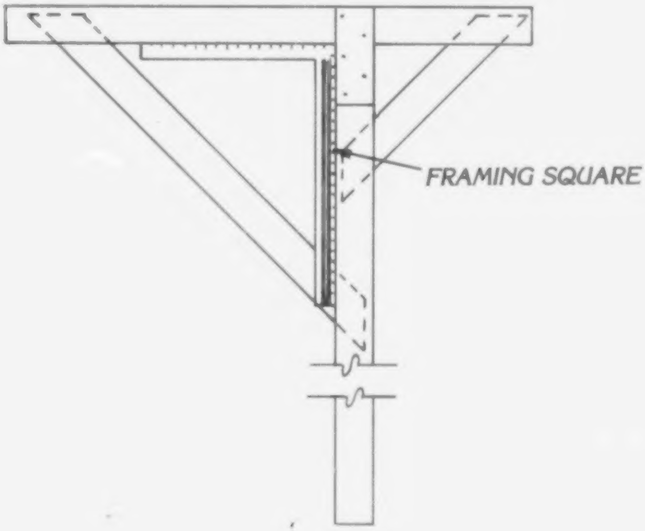
   (NOTE: Shore head should be off center of the shore to facilitate installation and bracing of outer beam side.)

FIGURE 14


SHORE HEAD
EQUAL TO HEIGHT OF BEAM SIDE
SHORE

3. Square shore head on shore and nail scab across joint, using 2×4 scab and 16d duplex nails (Figure 15)

FIGURE 15


FRAMING SQUARE

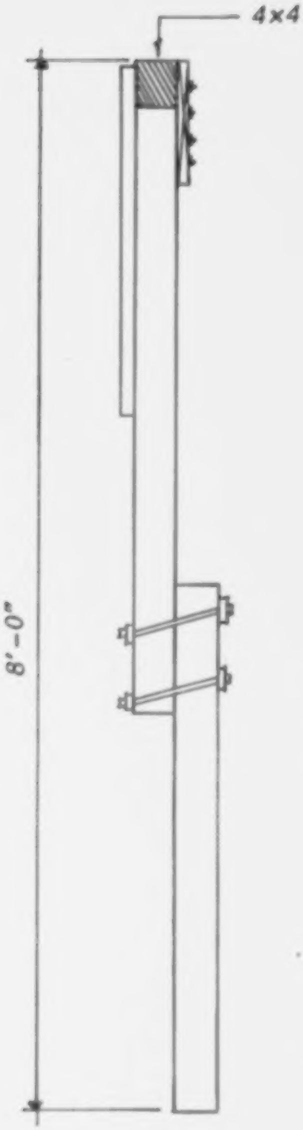
JOB SHEET #1

4. Install braces as shown by dotted lines in Figure 15

   (NOTE: Check relationship of shore head and shore with framing square.)

5. Join the two pieces of shore with patented clamps (Figure 16)

FIGURE 16



JOB SHEET #1

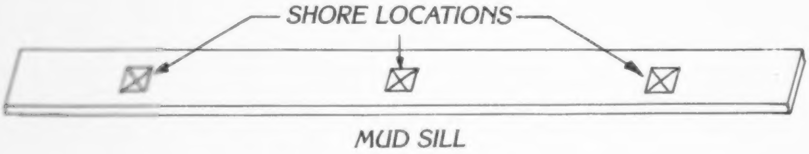
6. Check for approximate shore length and tighten clamps

E. Erect shores and beam form

1. Lay mud sills on center line of beam (Figure 17)

   (NOTE: If ground is not stable, cross another line of mud sill at shore locations.)

FIGURE 17



2. Nail stringer to two shore heads directly over shore

   (NOTE: The shore at the column end should be held back approximately one foot from the end of the stringer. The other shore should have the stringer end centered on the shore head.)

3. Stand assembled unit upright on mud sills and brace plumb in both directions

   (NOTE: When setting upper floors, use a single sill at the beam center line. This will permit anchorage at the base of the shore.)

4. Proceed with steps 2 and 3 until entire length of beam is shored

5. Install remaining stringers (Figures 18 and 19)

   (NOTE: Side stringers should be installed at beam edges and in position to receive nails through kicker. Stringers do not have to be cut as they can be lapped on the shore head.)

JOB SHEET #1

FIGURE 18

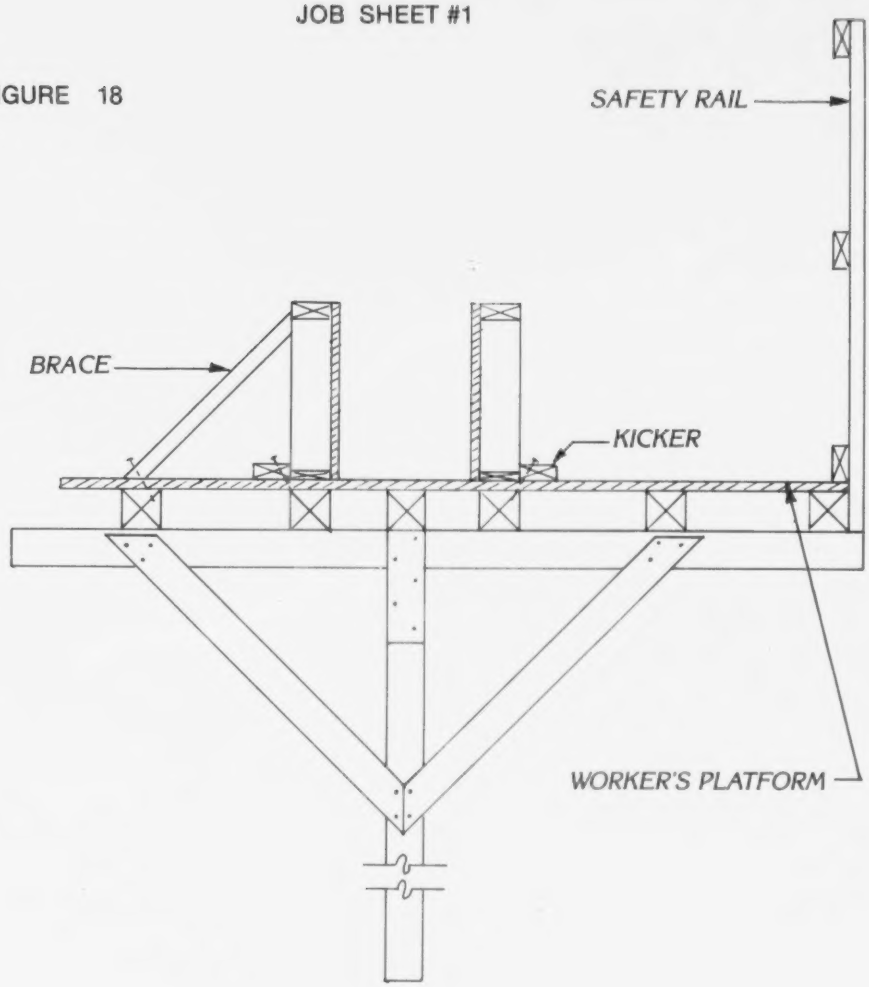
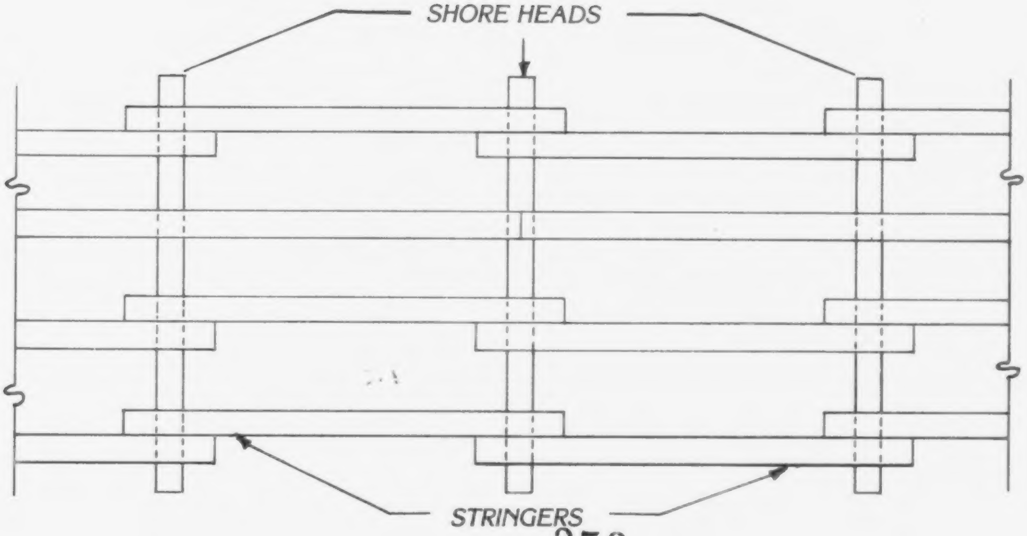

SAFETY RAIL
BRACE
KICKER
WORKER'S PLATFORM

FIGURE 19


SHORE HEADS
STRINGERS

JOB SHEET #1

6. Nail plywood decking to the stringers the entire length of the beam

   (NOTE: This decking should be wide enough to provide walkway for workers with safety rails where required.)

7. Snap chalk lines on the plywood, locating both sides of the beam

8. Stand beam sides on plywood and nail through plate to stringer

   (NOTE: If stringers were lapped as shown in Figure 19, short stringers which cross at least two shore heads might have to be added to facilitate nailing of the form or kicker.)

9. Brace to approximate line by plumbing beam side with a hand level

   (NOTE: If spreader ties are used, be sure to install them after the first beam side is set.)

F. Install kickers

(NOTE: Kickers may be installed prior to beam side installation if it is more convenient to do so.)

G. Install walers on the rows of ties below the row of nail point ties at this time

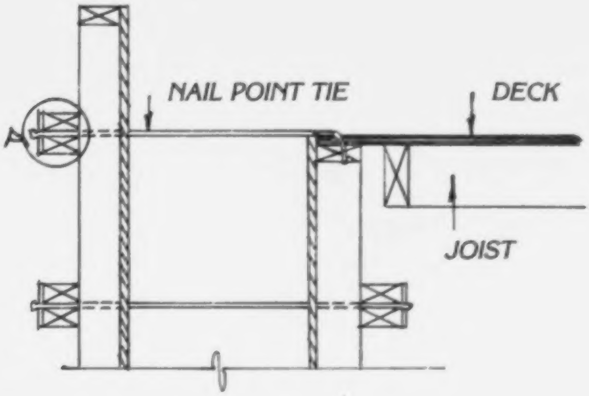
H. Secure all form tie heads

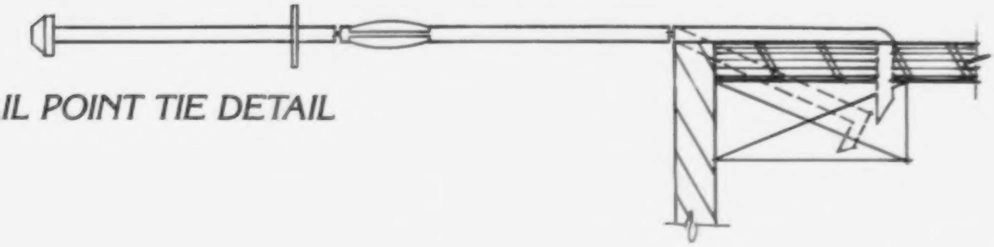
JOB SHEET #1

I. Install and secure row of nail point ties and align beam side (Figure 20)

(NOTE: This row of ties is installed after the deck is in place on top of the inner beam side. Use string line to align top of beam side.)

FIGURE 20





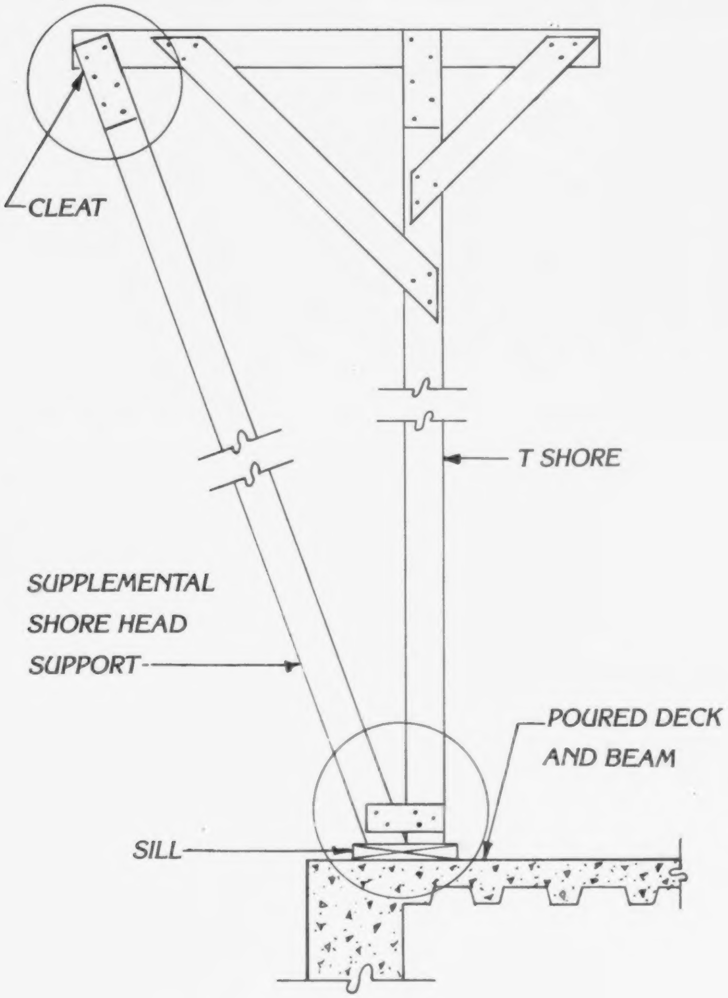
NAIL POINT TIE DETAIL

JOB SHEET #1

J. Install supplemental shore head supports (Figure 21)

(NOTE: Supplemental shore head supports are necessary where load is off center of shore, where safety rail is needed, and on second floor and above.)

FIGURE 21


CLEAT
T SHORE
SUPPLEMENTAL SHORE HEAD SUPPORT
POURED DECK AND BEAM
SILL

HORIZONTAL BEAM FORMS
UNIT VII

JOB SHEET #2 — CONSTRUCT AN INTERIOR BEAM FORM

I. Tools and materials

   A. Tools

      1. Claw hammer
      2. Handsaw
      3. Power handsaw and extension cord
      4. Folding rule or steel tape
      5. Thirty-inch hand level
      6. String line
      7. Shore jack
      8. Builder's level

   B. Materials

      1. Plywood sheathing
      2. 2×4s for kickers, plates, studs, and cleats
      3. Patented shores
      4. 2×10s or larger for sills
      5. 2×10s for beam bottom
      6. 8d and 16d duplex nails and 6d and 8d box nails

II. Procedure

   A. Determine beam size

      (NOTE: On the job, this information will be secured from the structural plans and beam schedule.)

   B. Cut plywood to width for beam sides (Figure 22)

      (NOTE: When figuring beam side widths, be sure to add beam bottom thickness and deduct decking thickness.)

JOB SHEET #2

FIGURE 22a

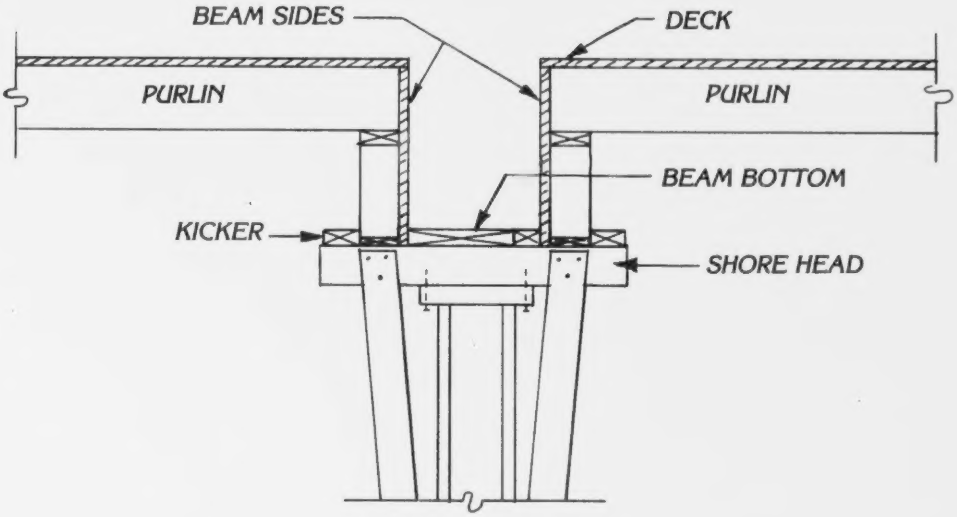
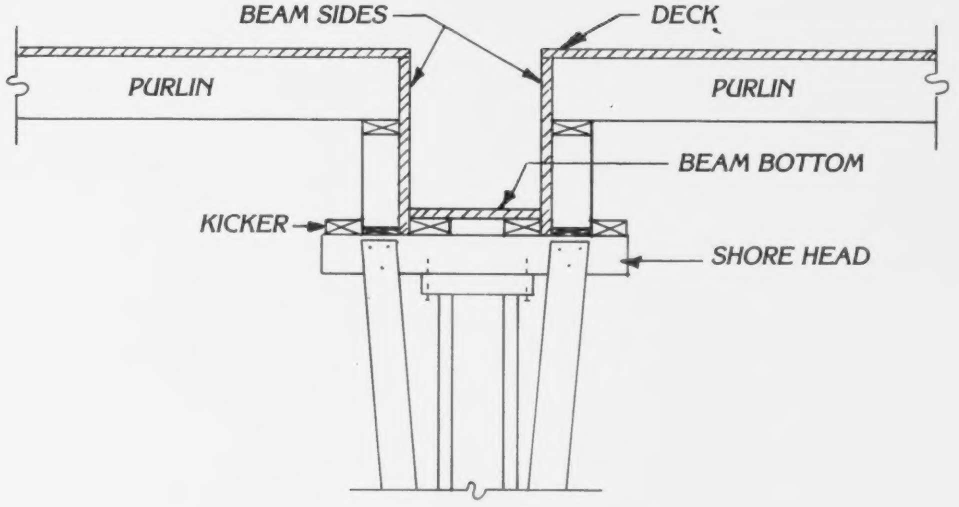

BEAM SIDES
DECK
PURLIN
PURLIN
BEAM BOTTOM
KICKER
SHORE HEAD

FIGURE 22b — Alternate Method


BEAM SIDES
DECK
PURLIN
PURLIN
BEAM BOTTOM
KICKER
SHORE HEAD

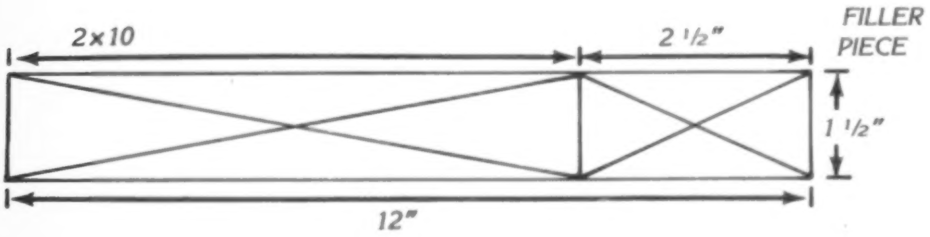
JOB SHEET #2

C. Build beam bottom

1. Cut filler piece to correct width (Figure 23)

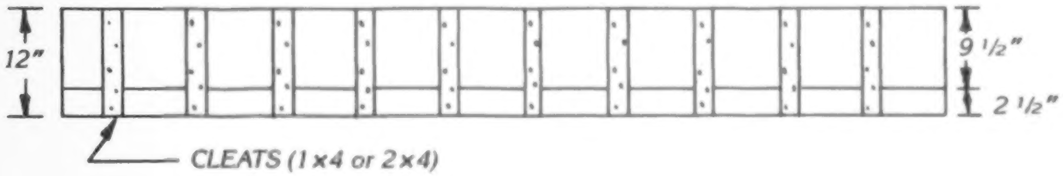
   (NOTE: Figure correct width of material to rip with the least waste. It is better to cut two pieces from one piece if the waste is less. Straight material should be used. If a 2×4 was used to cut the 2 ½-inch piece, there would be 1-inch waste; if two pieces 2 ½-inches wide are cut from a 2×6, there would be less than ½-inch waste.)

FIGURE 23



2. Cleat the pieces together spacing cleats to miss shore location (Figure 24)

FIGURE 24



D. Build "T" shores

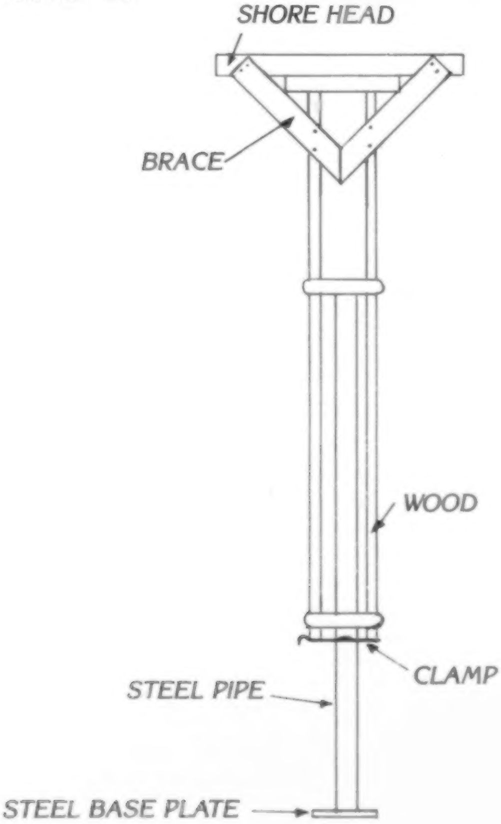
1. Cut shore heads

   (NOTE: If braces are needed on beam side, shore heads will have to be long enough to receive the bottom end of the brace.)

JOB SHEET #2

2. Nail shore head to shore (Figure 25)

FIGURE 25


SHORE HEAD
BRACE
WOOD
CLAMP
STEEL PIPE
STEEL BASE PLATE

3. Install shore head braces

(NOTE: Make sure that the bottom of the brace does not interfere with upper pipe guide when shores are adjusted to height.)

E. Erect shores, beam bottom, and beam sides

1. Lay sill pieces on the deck at beam centerline

2. Nail beam bottom to two "T" shores

(NOTE: The shore at the column should be held back approximately one foot from the end of the beam bottom. The other end of the beam bottom will be centered on the shore head.)

JOB SHEET #2

3. Stand the assembly upright on the sill; plumb and brace in both directions

   (NOTE: If beam bottom is too heavy to handle as outlined in steps 2 and 3, erect "T" shores individually; then install beam bottom.)

4. Erect intermediate shores

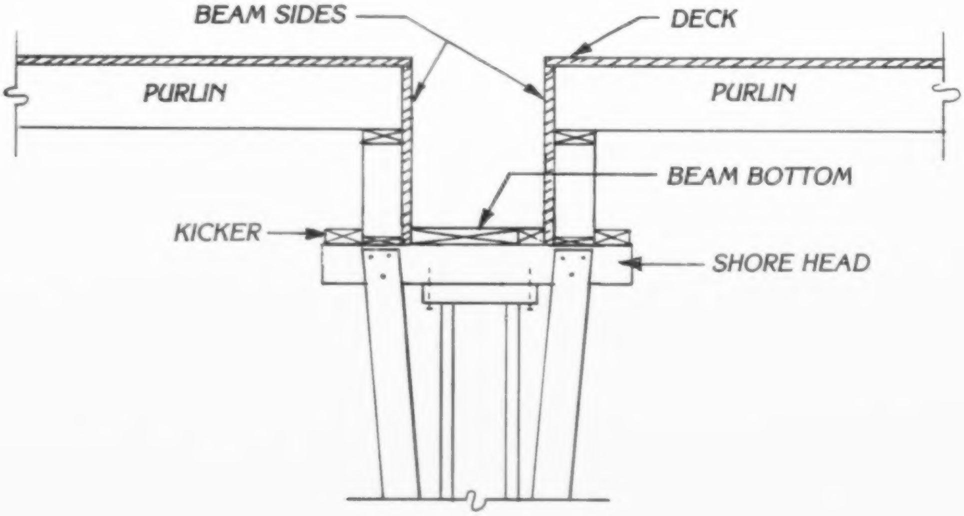
5. Level beam bottom

6. Nail beam sides to beam bottom

   (NOTE: Nailing should be held to a minimum, just enough to hold until kicker is in place. Nailing that is done should be between shore heads. In this location, the nails help hold the concrete pressure on the beam bottom.)

7. Nail continuous kicker to shore heads using two 16d nails per shore head; nail tightly against beam side using draw nails if necessary (Figure 26)

FIGURE 26



HORIZONTAL BEAM FORMS
UNIT VII

JOB SHEET #3 — CONSTRUCT A POST-TENSIONED INVERTED BEAM FORM

I. Tools and materials

A. Tools

1. Claw hammer
2. Handsaw
3. Power handsaw and extension cord
4. Folding rule or steel tape
5. Hand level
6. String line
7. Electric drill motor, 1/4" or 3/8"
8. Drills
9. Builder's level and rod

B. Materials

1. Plywood
2. 2×4s for studs, upper plates, kickers, and walers
3. Patented scaffold shores
4. 4×4s or 4×6s for stringers
5. 2×10s or larger for sills
6. Form ties with spreader washers
7. Form supports, 1/2" thin wall conduit; 1/4" allthread rod
8. 1×4s for bottom plates
9. 8d and 16d duplex nails and 6d and 8d box nails

JOB SHEET #3

II. Procedure

A. Secure material

B. Determine beam size

(NOTE: On the job, this information will be secured from the structural plans and beam schedule.)

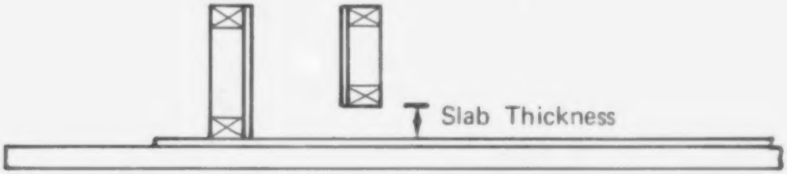
C. Fabricate beam sides

1. Cut plywood to proper width

2. Cut studs and plates to length (Figure 27)

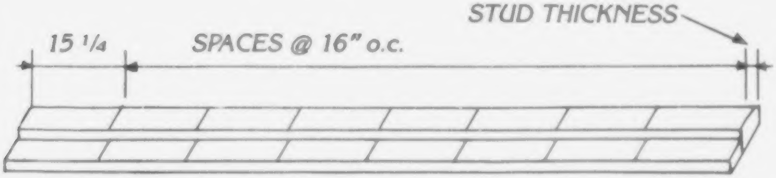
(NOTE: Beam side heights differ by the thickness of the slab.)

FIGURE 27


Slab Thickness

3. Lay out stud spacing on plates (Figure 28)

FIGURE 28


STUD THICKNESS
15 1/4
SPACES @ 16" o.c.

JOB SHEET #3

4. Nail studs to plate (Figure 29 and 30)

   (NOTE: A 1-inch plate is used on the bottom so the studs will bear against the kicker. See Figure 30.)

FIGURE 29

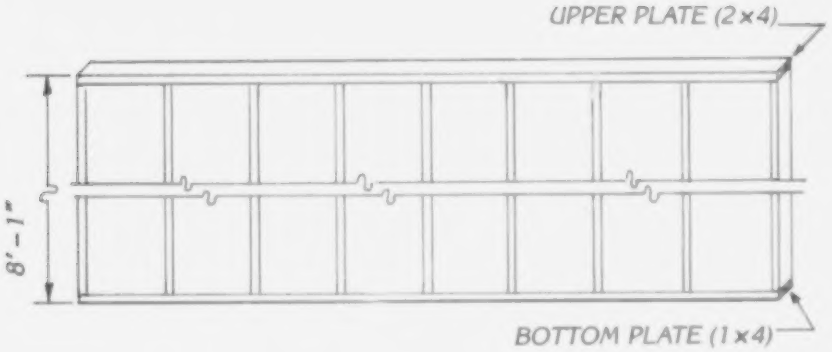
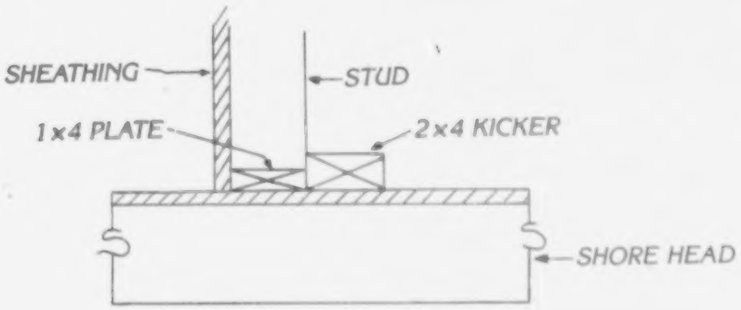

UPPER PLATE (2×4)
8'–1"
BOTTOM PLATE (1×4)

FIGURE 30


SHEATHING
STUD
1×4 PLATE
2×4 KICKER
SHORE HEAD

5. Nail sheathing to stud frame

   (NOTE: Sheathing should be flush with all four edges of stud frame.)

6. Build required number of beam sides following steps 1 to 5

D. Drill from tie holes

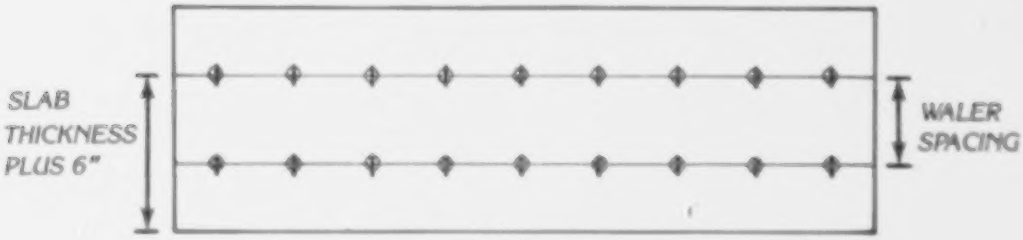
1. Follow manufacturer's recommendations or specifications for waler and tie spacing

JOB SHEET #3

2. Lay out and drill form tie holes

   (NOTE: Bottom row of ties should be slab thickness plus 6 inches. See Figure 31.)

FIGURE 31



3. Drill form tie holes in inside and outer beam side using the first beam side drilled for a pattern

E. Erect scaffold

(NOTE: The patent scaffold will actually shore the slab deck which is on the same level as the beam bottom.)

1. Lay sill pieces on deck, locating them one-half the frame width each side of column centerline

2. Set two adjustable screw legs in approximate final location: 1 foot from column face

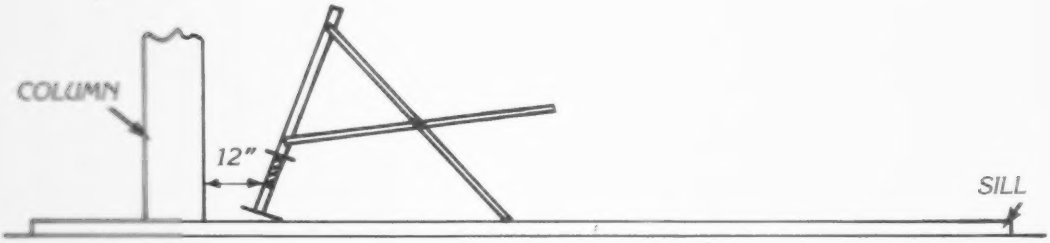
3. Attach screw legs to scaffold

   (NOTE: Screw legs must have base plates.)

JOB SHEET #3

4. Stand scaffold upright and attach two braces, lean scaffold and secure top section of brace first (Figure 32)

FIGURE 32



5. Attach second frame by raising brace until it aligns with pins on frame

   (NOTE: If wing nuts are used to attach braces, catch only enough threads to hold the nut on, for they will have to be removed to install the next brace.)

6. Install braces to last frame set

7. Set next frame with screw legs installed

8. Repeat steps 6 and 7 to continue erection

9. Place coupling in top of scaffold frame

   (NOTE: Some patented scaffolds have a small bottom end which slips inside the top of the lower frame; therefore, coupling pins are not used.)

10. Place plank on top of first row of frames

11. Set second row of frames on pins

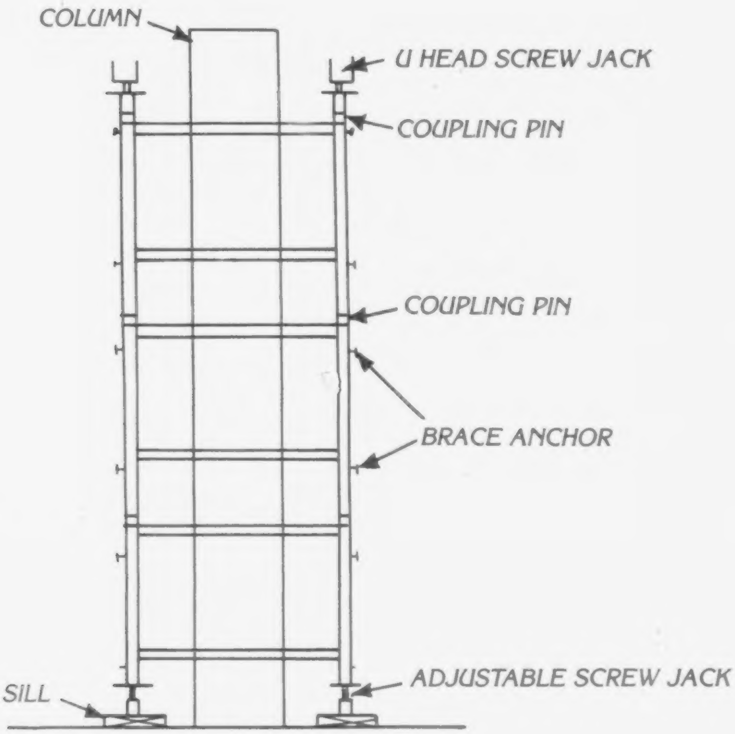
12. Attach braces

13. Continue to set frames as outlined in steps 9 through 12 until desired height is reached

JOB SHEET #3

14. Install U-head screw jack on all frame posts to approximate level (Figure 33)

FIGURE 33


COLUMN
U HEAD SCREW JACK
COUPLING PIN
COUPLING PIN
BRACE ANCHOR
SILL
ADJUSTABLE SCREW JACK

SCAFFOLD SHORE

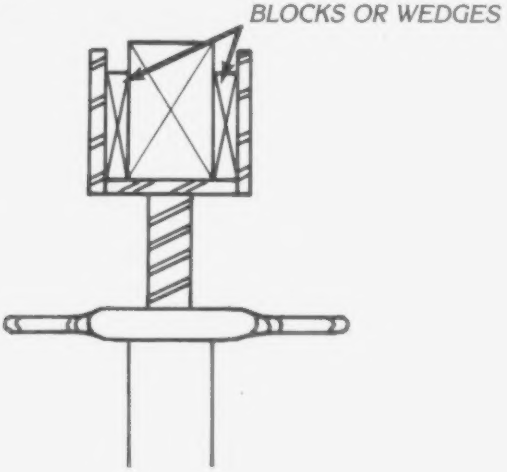
JOB SHEET #3

F. Install stringers, joist, and decking

1. Lay stringers in U-head screw jack (Figure 34)

   (NOTE: If stringers are not as wide as head, block from both sides so stringer is centered.)

FIGURE 34



2. Lay joists across stringers and nail in place

   (NOTE: Project joists past the stringer at not more than 4-foot intervals to facilitate beam side bracing.)

3. Nail plywood to joists

4. Level beam bottom

G. Install beam sides

1. Snap chalk line on deck locating face of beam

   (NOTE: Refer to Figure 27.)

2. Set widest beam side on deck

3. Line beam side with chalk line and nail to joist

4. Install kicker tightly against beam side

5. Brace beam side plumb

JOB SHEET #3

H. Make form supports

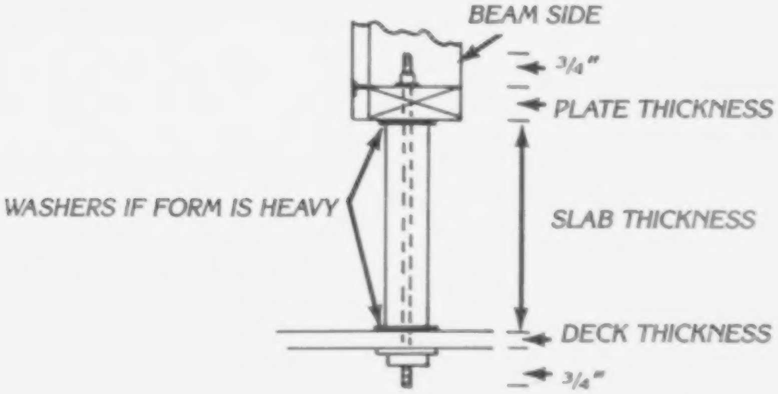
1. Cut conduit into lengths equal to slab thickness

   (NOTE: If form is heavy, deduct the thickness of two ³/₈-inch washers from the slab thickness to determine conduit length.)

2. Cut ¹/₄-inch allthread rod to length (Figure 35)

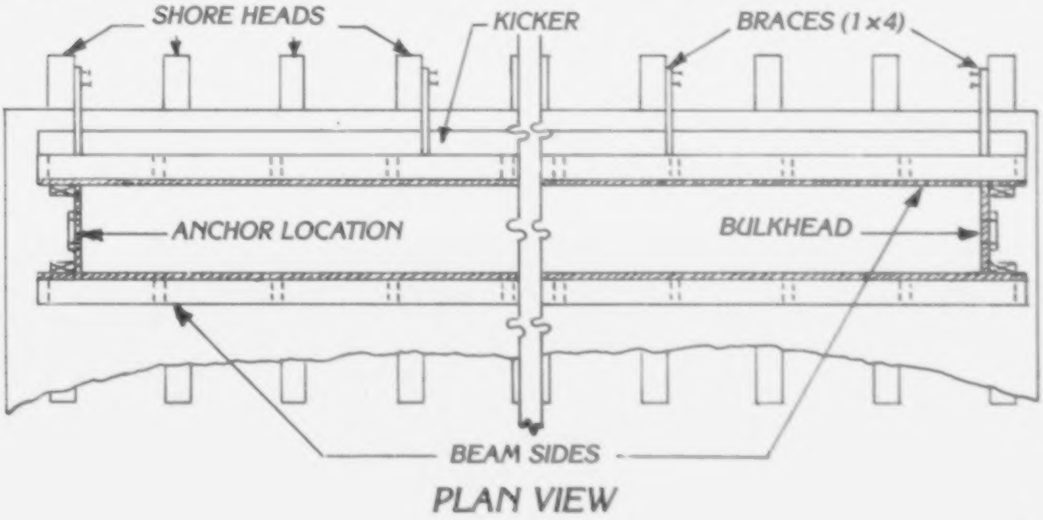
   (NOTE: The length of allthread needed is determined by the thickness of the slab, the deck, and the plate plus 1 ¹/₂" inch for nuts and washers.)

FIGURE 35


BEAM SIDE
3/4"
PLATE THICKNESS
WASHERS IF FORM IS HEAVY
SLAB THICKNESS
DECK THICKNESS
3/4"

I. Build and install bulkheads at both ends of beam (Figure 36)

FIGURE 36


SHORE HEADS
KICKER
BRACES (1 x 4)
ANCHOR LOCATION
BULKHEAD
BEAM SIDES
PLAN VIEW

JOB SHEET #3

J. Drill holes in bulkhead for post-tensioning anchors

(NOTE: Form oil must be applied before installation of post-tensioning tendons and rebars. The locations of the anchors will be shown on the plan or shop drawing.)

K. Install walers

(NOTE: Make sure that the walers are centered on the tie holes. Place form ties through form and waler and secure head.)

L. Erect inner beam side

1. Tack a temporary support to the stud on the inner beam side

   (NOTE: Leg should extend below the beam side a distance equal to the slab thickness plus ¼".)

2. Rest the form on the supports and guide form ties through holes in beam side

   (NOTE: Nail a cleat across the top of the forms to hold it upright.)

3. Push form against spreader washers and drill holes for permanent supports

   (NOTE: Use a long bit so hole in plate and deck can be drilled at the same time.)

4. Install walers and secure tie clamps

M. Install permanent beam supports

1. Screw nut on one end of allthread rod

2. Place washer on rod and insert in the hole of the plate

3. Hold conduit under the plate and insert rod through it and the deck

4. Screw nuts on rod under the deck

   (NOTE: These supports also serve to keep the form from floating when the concrete is poured.)

5. Remove temporary supports

   (NOTE: Post-tensioning is completed after the concrete has reached the designated strength. Beam bottom must be left in place until beam is post-tensioned.)

HORIZONTAL BEAM FORMS
UNIT VII

TEST

NAME ______________________________ SCORE ______________

1. Match to their correct definitions terms associated with horizontal beam forms. Write the correct numbers in the blanks. Terms and definitions are continued on the next page.

______a. Piece of wood or other material that directs, resists, or supports weight or pressure

______b. Form tie with one end bent 90 degrees and pointed

______c. Piece of material nailed across a splice to strengthen and hold it together

______d. Piece of wood used to hold sides of forms apart; is removed as the concrete is poured or may be integral part of form tie

______e. Strip of wood or metal fastened across a form for temporary positioning or to replace a form tie

______f. Prop placed against or beneath an object for support

______g. Horizontal timber placed across a shore and braced squarely

______h. That part of beam form that supports vertical pressure

______i. Piece of material used to resist horizontal pressure

______j. Exterior or perimeter beam spanning two structures to support structure above

______k. Piece of heavy material placed across several shores; horizontal or inclined supporting member

______l. Single or multistrand of high-tensile wire or a rod used top stress concrete

______m. Method of prestressing reinforced concrete in which tendons are tensioned after the concrete has hardened

1. Kicker
2. Shore head
3. Beam bottom
4. Spandrel beam
5. Cleat
6. Tendon
7. Scab
8. Shore
9. Nail point tie
10. Stringer
11. Brace
12. Spreader
13. Post-tensioning

TEST

______n. Horizontal timber laid directly on ground to support frame structure

______o. Paraffin oil or other manufactured product used on a form to prevent adhesion of concrete to form

______p. Horizontal board used to hold shores in alignment and to resist lateral movement

______q. Tapered piece of wood or metal

______r. Stud frame and sheathing section that comprise vertical section of a beam form

______s. Large piece of wood or other material laid flat on floor and upon which scaffolds or shores are set

______t. Holes that are exposed in concrete when form snap ties are removed

______u. Horizontal brace used in form construction

______v. Tool used to jack up some patented shores

______w. Type of form that does not require intermediate shoring

14. Mud sill
15. Beam side
16. Waler
17. Form oil
18. Wedge
19. Tie holes
20. Shore jack
21. Sill
22. Ribbon
23. Steel plate girder

TEST

2. Identify the parts of a beam form illustrated below. Write the correct numbers in the blanks.

_____a. Top plate

_____b. Stud

_____c. Sheathing

_____d. Beam side

_____e. Beam bottom

_____f. Bottom plate

_____g. Kicker

_____h. Stringer

_____i. Shore head

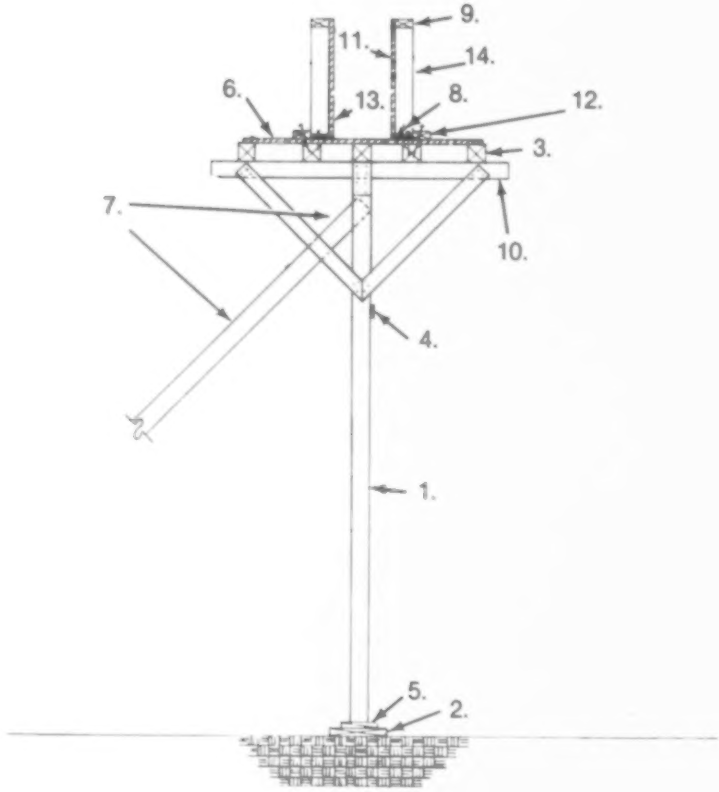
_____j. Brace

_____k. Ribbon

_____l. Shore

_____m. Wedge

_____n. Mud sill



3. Name types of beams.

a. ____________________

b. ____________________

c. ____________________

4. List materials used to construct beam forms.

a. ____________________

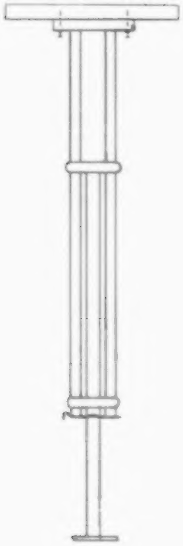
b. ____________________

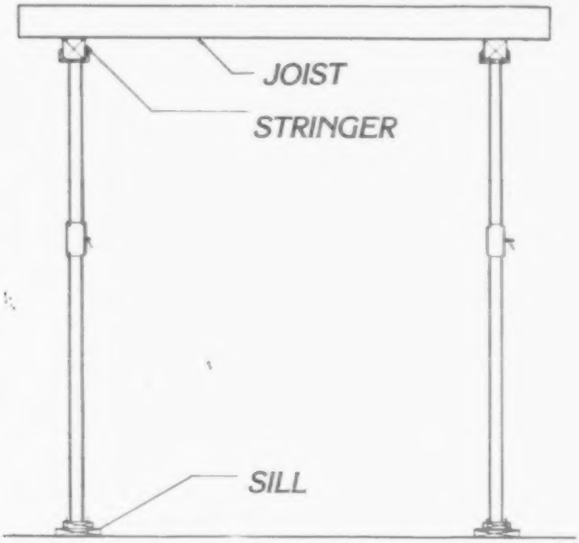
c. ____________________

TEST

5. Identify the following types of beam shores. Write the correct names in the blanks.

Wood "T" shore with wedges	**Patented adjustable steel post**
Wood "T" shore with manufactured clamps	**Patented tubular-steel, scaffold-type**
Patented wood and metal "T" shore	**Patented tubular-steel, scaffold-type with purlins and beams**

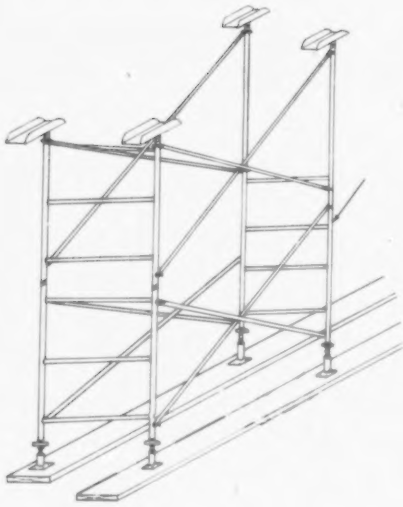


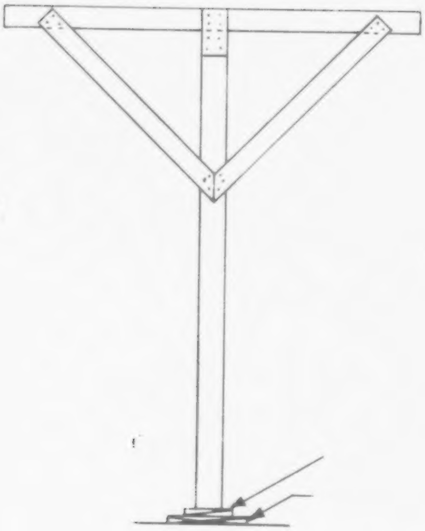


a. ______________________

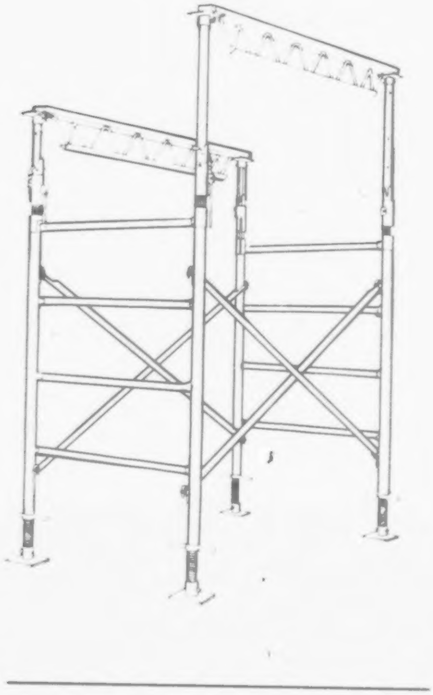
b. ______________________

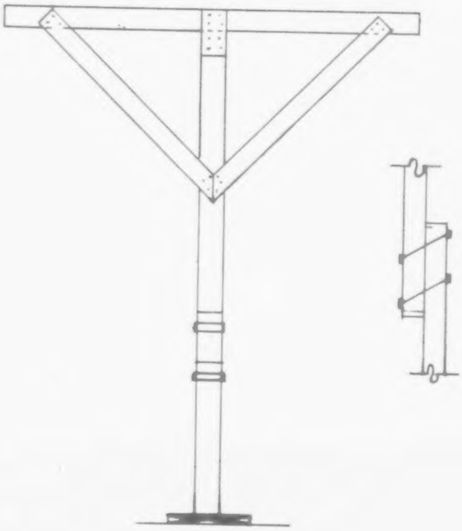
TEST





c. ______________________________ d. ______________________________





e. ______________________________ f. ______________________________

TEST

(NOTE: Test question 6 lists the job sheets. They are an important part of this test. If they have not been completed check with your instructor.)

6. Demonstrate the ability to

   a. Construct a spandrel beam form.

   b. Construct an interior beam form.

   c. Construct a post-tensioned inverted beam form.

HORIZONTAL BEAM FORMS
UNIT VII

ANSWERS TO TEST

1. a. 11
   b. 9
   c. 7
   d. 12
   e. 5
   f. 8
   g. 2
   h. 3
   i. 1
   j. 4
   k. 10
   l. 6
   m. 13
   n. 14
   o. 17
   p. 22
   q. 18
   r. 15
   s. 21
   t. 19
   u. 16
   v. 20
   w. 23

2. a. 9
   b. 14
   c. 11 or 13
   d. 13 or 11
   e. 6
   f. 8
   g. 12
   h. 3
   i. 10
   j. 7
   k. 4
   l. 1
   m. 5
   n. 2

3. a. Spandrel
   b. Interior
   c. Inverted

4. Answer should include any three of the following

   a. Wood
   b. Metal
   c. Molded fiberglass
   d. Combination fiberglass and wood or metal

5. a. Patented wood and metal "T" shore
   b. Patented adjustable steel post
   c. Patented tubular steel type
   d. Wood "T" shore with wedges
   e. Patented tubular steel with purlins and beams
   f. Wood "T" shore with manufactured clamps

6. Performance skills evaluated to the satisfaction of the instructor

ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

UNIT OBJECTIVE

After completing this unit, the student should be able to identify types of forming systems and should be able to construct various types of forms. The student should also be able to strip forms and should be able to set void tubes and screeds. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with above-grade slab systems.
2. Identify parts of a slab forming system.
3. Identify types of forming systems used for concrete slabs.
4. Select from a list materials used to construct pans and domes.
5. List types of materials used for permanent forms.
6. List types of materials used to form concealed voids and ducts in concrete.
7. Name types of manufactured exposed void forms.
8. Demonstrate the ability to
    a. Construct forms for a two-way joist system.
    b. Construct forms for a one-way joist system.
    c. Strip a two-way joist system.
    d. Set concealed void tubes.
    e. Set screeds on a deck for a flat slab.

ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Transparency master: TM #1 — Parts of a Slab Forming System

   D. Information sheet

   E. Job sheets

      1. Job Sheet #1 — Construct Forms for a Two-Way Joist System

      2. Job Sheet #2 — Construct Forms for a One-Way Joist System

      3. Job Sheet #3 — Strip a Two-Way Joist System

      4. Job Sheet #4 — Set Concealed Void Tubes

      5. Job Sheet #5 — Set Screeds on a Deck for a Flat Slab

   F. Test

   G. Answers to test

II. Instructor's guide

   A. Review unit and plan presentation.

   B. Order or obtain materials to supplement unit.

      1. Equipment and materials for job sheet procedures

      2. Pictures and literature on the different types of slab form systems

         EXAMPLES: Flying form, slip forms, traveling forms, lift slabs placed on ground, tilt-up slabs placed on ground or prefabricated, prefabricated slabs, prestressed slabs, post-tensioned slabs

      3. Examples of a void tube and dome form

      4. Transparency and competency profiles

SUGGESTED ACTIVITIES

(NOTE: The transparency and competency profiles for this manual are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

C. Provide students with unit.

D. Introduce unit.

SUGGESTIONS:

- Explain to students the different types of slab form systems.

  EXAMPLE: Flying forms, slip forms, traveling forms, lift slabs placed on ground, tilt-up slabs placed on ground or prefabricated, prefabricated slabs, prestressed slabs, post-tensioned slabs

- Explain how they work, where they are used, and why they are used.
- Make a bulletin board displaying the various types of slab form systems.
- Discuss types of construction in which the various slab forms are used.
- Discuss danger of form failures and blowouts
- Discuss unit and specific objectives.

E. Discuss information and job sheets.

1. Use Information Sheet, Section I to introduce students to terms associated with above-grade slab form.

   SUGGESTION:

   - Show students examples of the terms void tubes and dome forms.

2. Use Information Sheet, Section II to introduce students to the parts of a typical slab forming system.

   SUGGESTION:

   - Use Transparency #1 to assist you in illustrating your discussion.
   - Show the students a constructed slab form and have them identify the components.

3. Use Information Sheet, Section III to discuss types of forming systems used for concrete slabs.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Take students on a tour of commercial construction sites in the community so that they may see the different types of forming systems.
- Take students on a tour of the community so that they may see different types of concrete slabs. Discuss the forming system used for each.
- Discuss reasons for using one concrete slab forming system over another.
- Explain the use and benefits of using filigree forming systems.

4. Use Information Sheet, Sections IV and V to introduce students to materials used to construct pans, domes, and permanent forms.

SUGGESTIONS:

- Show students pans and domes constructed of various materials.
- Make a display of the materials used to construct permanent forms.
- Take the students on a tour of commercial construction sites in the community so that they may see forms constructed of the various materials listed in this section of the information sheet.
- Discuss the advantages and disadvantages of the various materials.

5. Use Information Sheet, Section VI to introduce students to materials used to form concealed ducts and voids in concrete.

SUGGESTIONS:

- Show students examples of forms constructed of each of the materials listed in this section of the information sheet.
- Take students on tour of commercial construction sites in the community so that they may see forms for concealed ducts and voids constructed of the materials listed in this section of the information sheet.
- Discuss the advantages and disadvantages of the various materials.

SUGGESTED ACTIVITIES

6. Use Information Sheet, Section VII to introduce students to the different types of manufactured exposed void forms.

   SUGGESTION:

   - Show students pictures or examples of each type of exposed void form. Discuss the applications, advantages, and disadvantages of each type.

F. Demonstrate and discuss Job Sheets #1 through #5.

G. Have students complete Job Sheets #1 through #5.

H. Give test.

I. Critique test and discuss in class.

J. Reteach and retest if necessary.

K. Complete appropriate section of competency profiles.

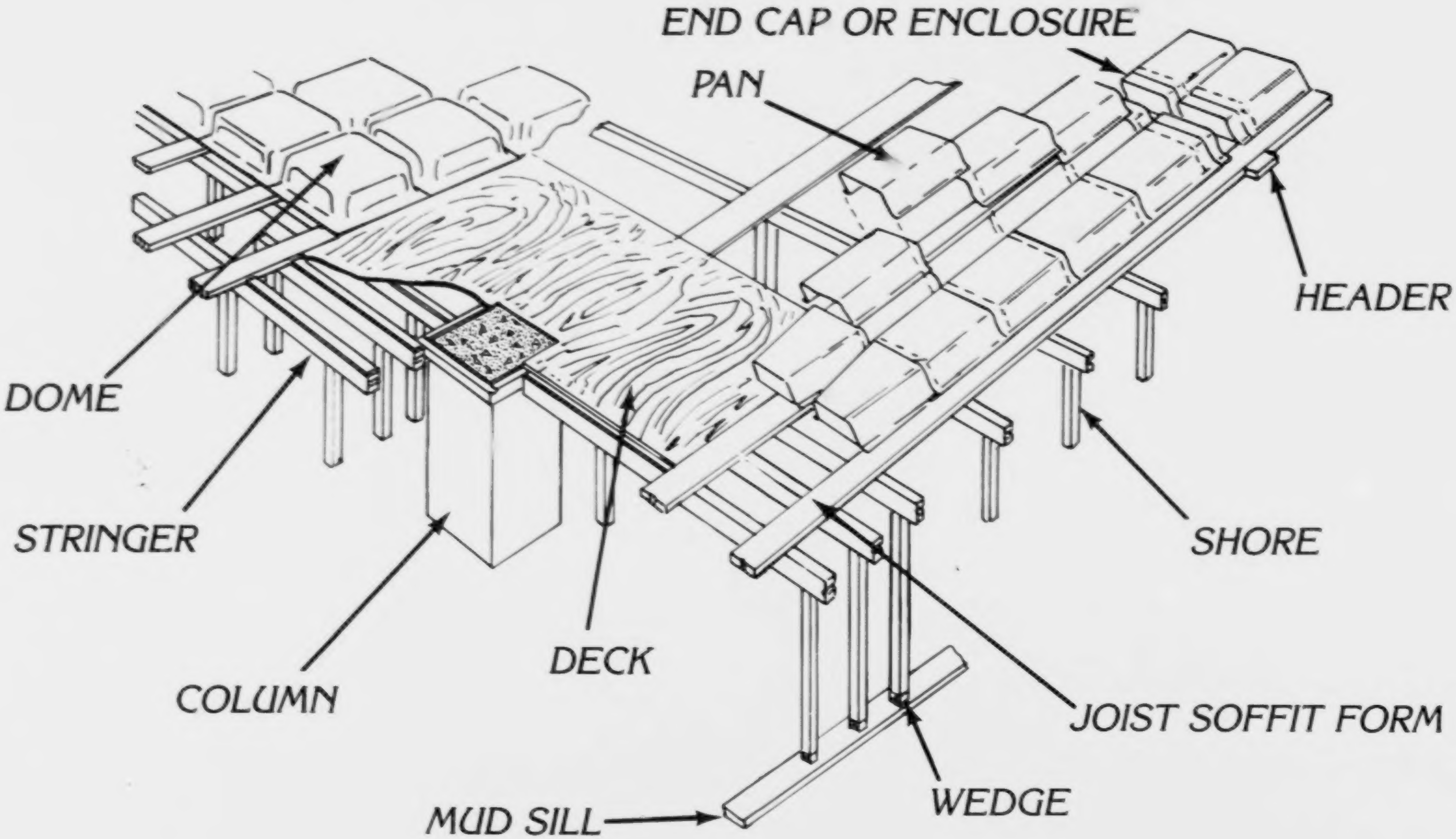
III. Unit references

A. Hendrix, Laborn J. "Bud." *Commercial Carpentry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

B. Hurd, M.K. *Formwork For Concrete.* 4th ed. Detroit, Michigan: American Concrete Institute, 1984.

C. Pamphlet, *The Filigree Wide Slab Method of Concrete Deck Construction,* Cranbury, New Jersey: Mid-State Filigree Systems, Inc.

Parts of a Slab Forming System


END CAP OR ENCLOSURE
PAN
HEADER
DOME
STRINGER
SHORE
COLUMN
DECK
JOIST SOFFIT FORM
WEDGE
MUD SILL

ABOVE-GROUND SLAB SYSTEMS
UNIT VIII

INFORMATION SHEET

I. Terms and definitions

  A. Shore — Prop placed against or beneath an object for support

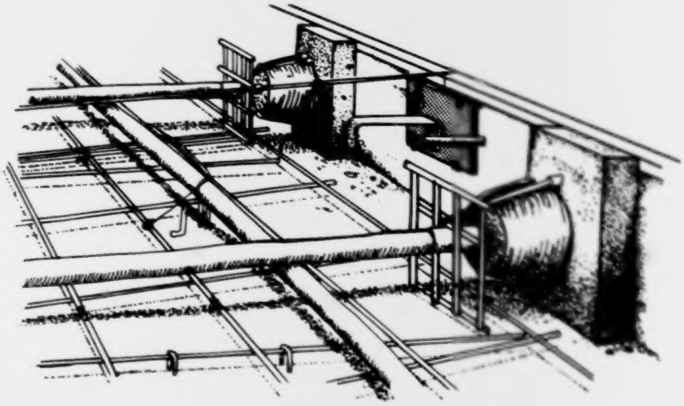
  B. Stringer — Piece of heavy material placed across several shores; horizontal or inclined supporting member

  C. Tendon — Single or multistrand of high tensile wire, or a rod used to stress concrete

  D. Post tensioning — Method of prestressing reinforced concrete in which tendons are tensioned after the concrete has hardened

  EXAMPLE: Post tensioning anchors for tendons attached to form

FIGURE 1



(NOTE: Concrete is cast around unstressed tendons enclosed in flexible metal or plastic ducts to prevent bond with concrete. After concrete hardens the tendons are stressed and anchored to the ends of the member, thus prestressing the concrete.)

  E. Ribbon — Horizontal board (brace) used to hold shores in alignment and to restrict lateral movement

  F. Pan — Single section of manufactured form used to mold exposed voids in a one-way joist system

  G. Void tube — Manufactured tube of metal or fiber used to create concealed voids in slabs

  H. Open centering — Framing for pans and domes comprised of joist soffit forms and headers

INFORMATION SHEET

I. Deck — Horizontal sheathing that supports wet concrete

J. Dome — Manufactured product that forms an exposed void in a waffle slab system

K. Waffle — Slab design in which concrete is poured on domes; two-way joist system

L. Flying form — System whereby a large section of slab form is removed with a crane and moved to the next pour location

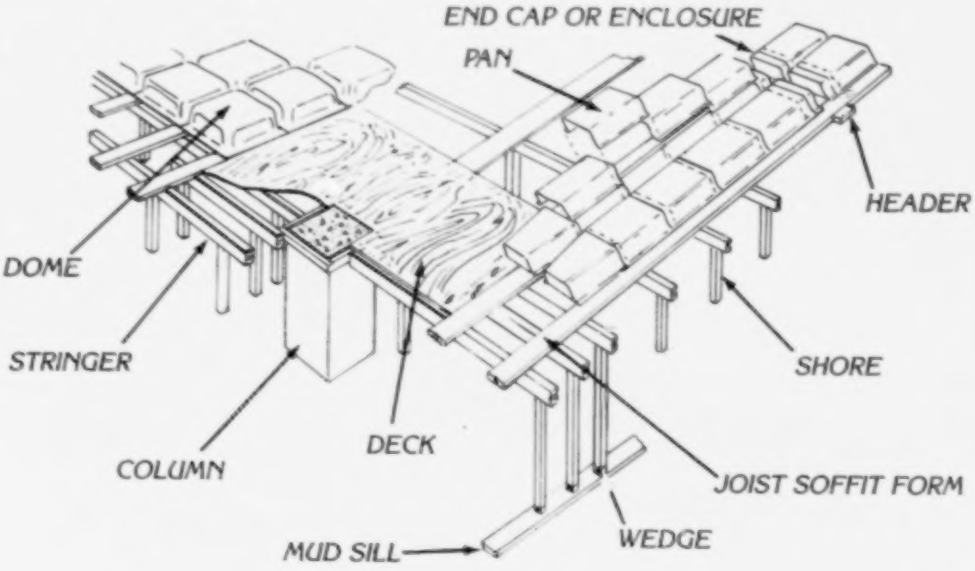
M. Mud sill — Horizontal timber laid directly on ground or floor to support a frame structure

N. Horizontal shores — Adjustable beam, truss, or beam and truss combination which supports formwork over clear spans and eliminates intermediate vertical supports

O. Form oil — Blend of oils applied to interior surface of forms to prevent concrete form adhering to the forms

II. Parts of a slab forming system (Figure 2)

FIGURE 2

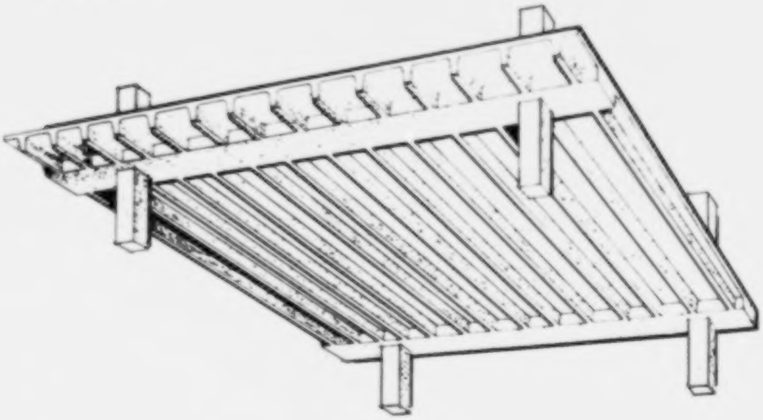

END CAP OR ENCLOSURE
PAN
HEADER
DOME
STRINGER
SHORE
COLUMN
DECK
JOIST SOFFIT FORM
WEDGE
MUD SILL

INFORMATION SHEET

III. Types of forming systems used for concrete slabs (Figures 3-8)

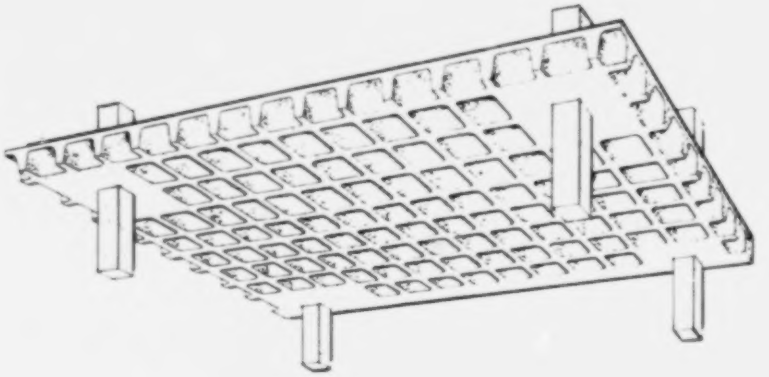
A. One-way joist system

FIGURE 3



B. Two-way joist system (Waffle slab)

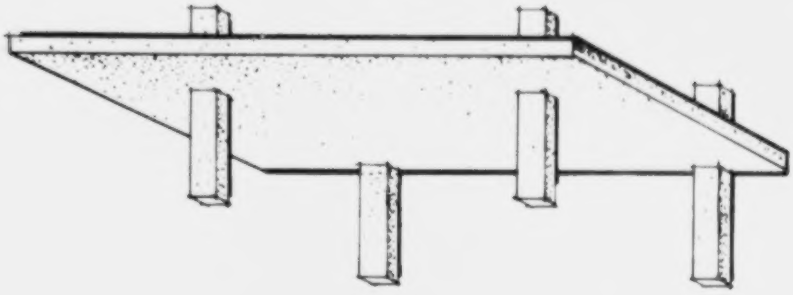
FIGURE 4



INFORMATION SHEET

C. Flat slab

FIGURE 5



D. Flat slab with drophead (drop panel)

FIGURE 6a

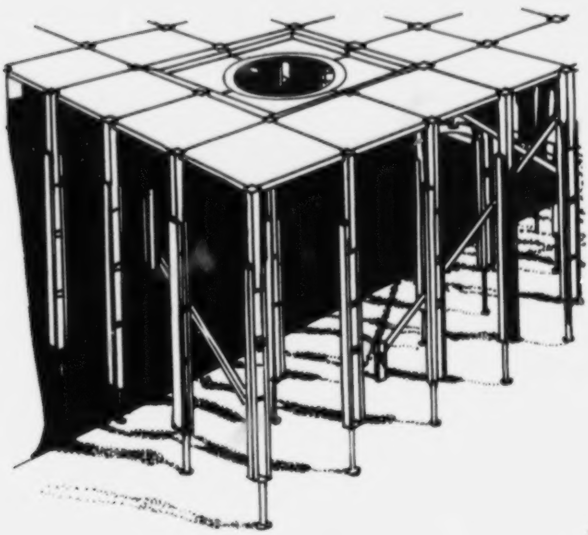
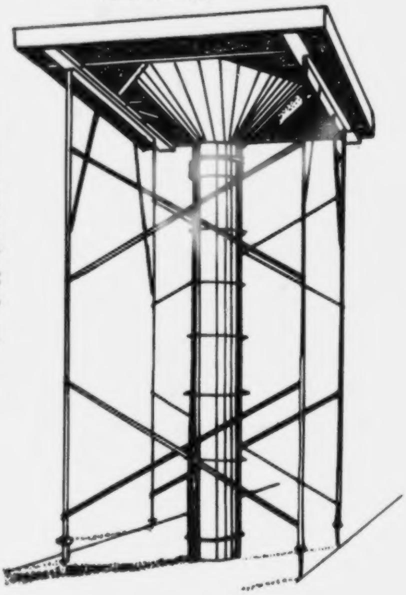


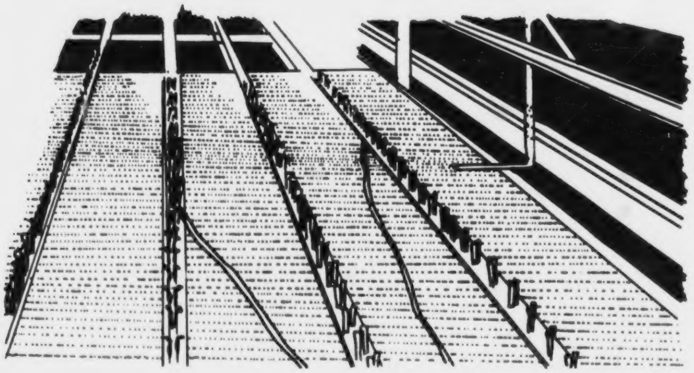
FIGURE 6b



INFORMATION SHEET

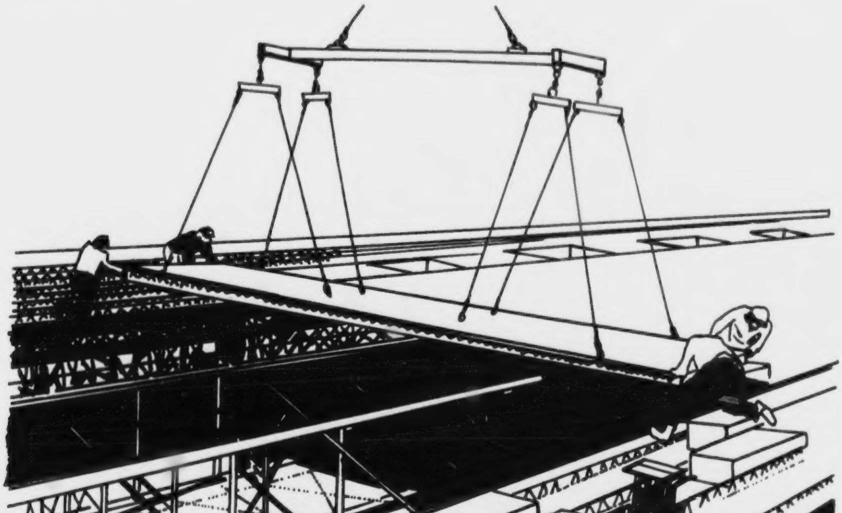
E. Permanent or stay-in-place system (metal decking)

FIGURE 7



F. Filigree system

FIGURE 8



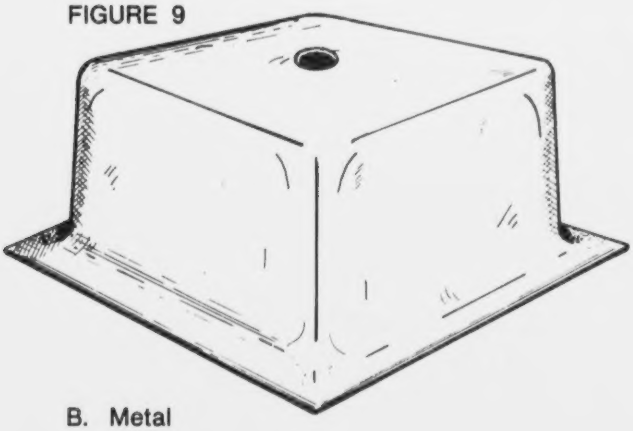
INFORMATION SHEET

IV. Materials used to construct pans and domes (Figures 9-11)

A. Molded fiberglass

EXAMPLE:

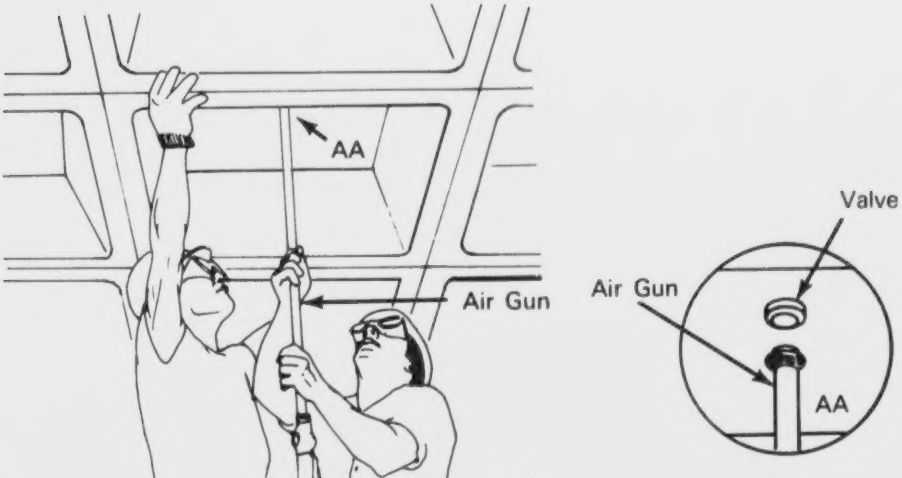
FIGURE 9



B. Metal

EXAMPLE:

FIGURE 10


AA
Air Gun
Valve
Air Gun
AA

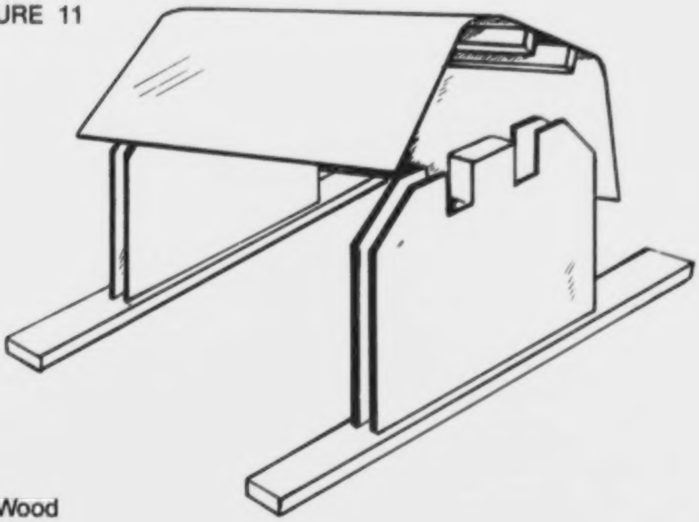
Air Valve

INFORMATION SHEET

C. Molded fiber (wood or paper)

EXAMPLE:

FIGURE 11



D. Wood

V. Materials used for permanent forms

A. Metal

B. Precast concrete

C. Wood

D. Plastic

E. Fiberboard

F. Reinforced water-repellent corrugated paper

G. Wire mesh with waterproof paper backing

H. Insulation board

I. Fabric

VI. Materials used to form concealed voids and ducts in concrete

A. Laminated fiber tube

B. Steel spirally-wound tubes

C. Corrugated cardboard

INFORMATION SHEET

D. Inflatable rubber tubing

E. Rubberized fabrics

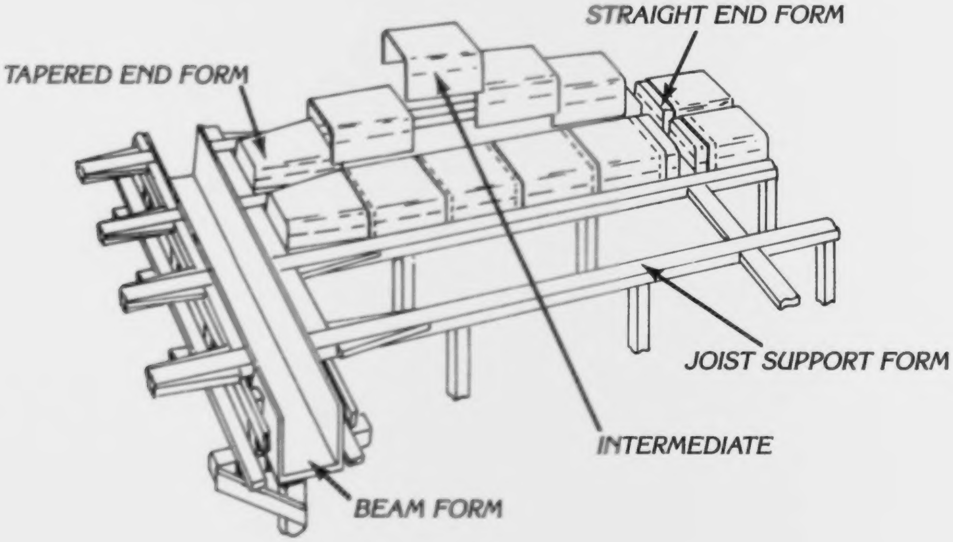
F. Expanded polystyrene

VII. Types of manufactured exposed void forms (Figures 12-15)

A. Adjustable form

EXAMPLE:

FIGURE 12

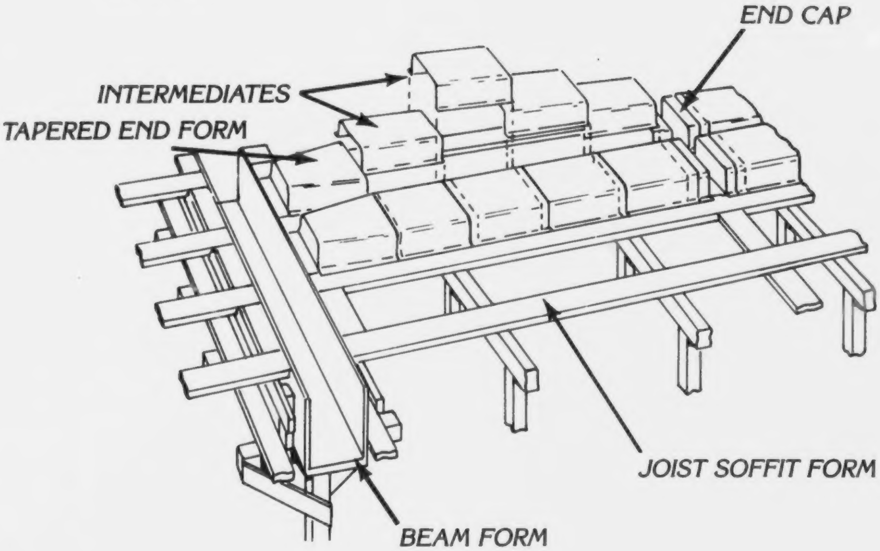

STRAIGHT END FORM
TAPERED END FORM
JOIST SUPPORT FORM
INTERMEDIATE
BEAM FORM

INFORMATION SHEET

B. Flange form

EXAMPLE:

FIGURE 13

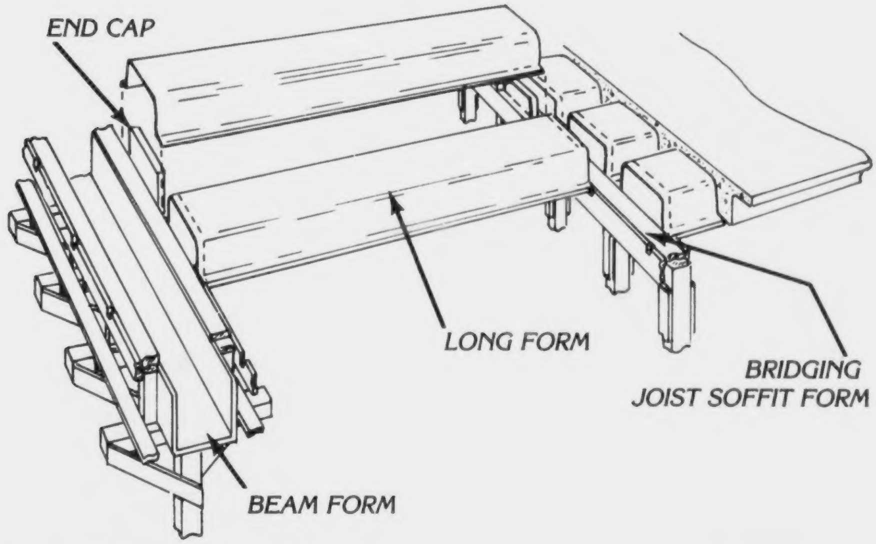

END CAP
INTERMEDIATES
TAPERED END FORM
JOIST SOFFIT FORM
BEAM FORM

INFORMATION SHEET

C. Long form

EXAMPLE:

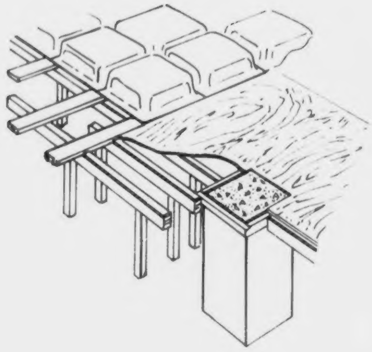
FIGURE 14


END CAP
LONG FORM
BRIDGING JOIST SOFFIT FORM
BEAM FORM

D. Dome form

EXAMPLE:

FIGURE 15



ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

JOB SHEET #1 — CONSTRUCT FORMS FOR A TWO-WAY JOIST SYSTEM

(NOTE: The shoring system used in this job sheet may be used on any type of slab. A solid plywood decking may also be installed.)

I. Equipment and materials

  A. Claw hammer

  B. Handsaw

  C. Power handsaw and extension cord

  D. Thirty-inch hand level

  E. Chalk line

  F. Builder's level

  G. String line

  H. Transit level

  I. Sawhorses

  J. Folding rule or steel tape

  K. 2×8s or larger for sills

  L. Shore frames (scaffold)

  M. Dome forms

  N. 2×8s or 2×10s for joist soffit form

  O. Plywood deck

  P. Horizontal shores

  Q. Nails for domes

  (NOTE: Check manufacturer's specifications.)

  R. 4×6s for stringers

  S. Form oil

JOB SHEET #1

T. Screw jacks

U. 6d and 16d duplex nails

V. Safety belt

W. Eye protection

II. Procedure

A. Erect shore frames

1. Lay sill pieces on deck

(NOTE: Sill locations should be one-half the frame width on each side of the column center line.)

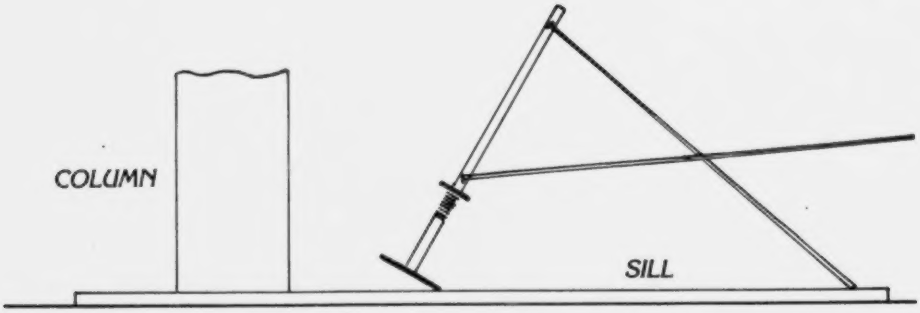
2. Set adjustable screw legs in approximate final locations (1-foot from column face)

3. Attach screw legs to scaffold

(NOTE: Screw legs must have base plates.)

4. Stand frame upright and attach two crossbraces, leaning top of frame as shown in Figure 16 to secure top brace first

FIGURE 16



5. Attach second frame by raising brace until it aligns with stud on frame

(NOTE: If wing nuts are used to attach braces, catch only enough threads to hold the nut on as they will have to be removed to attach the next brace.)

JOB SHEET #1

6. Attach braces to frame last set

7. Attach next frame to braces

8. Repeat steps 6 and 7 to continue erection

9. Place coupling pins in top of frame legs

   (NOTE: Some patented scaffolds have a small bottom end which slips inside the lower frame; therefore, coupling pins are not used.)

10. Place scaffold plank on top of frames

11. Set frame for second row on pins

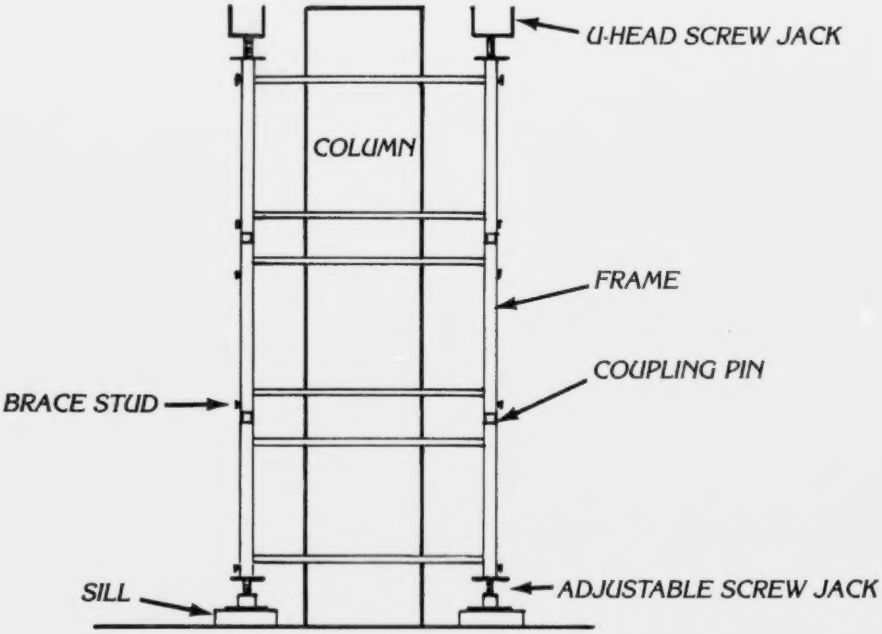
12. Attach braces

13. Set second frame and secure braces

14. Repeat steps 9 through 13 to continue erection

15. Install U-head screw jacks on all frame posts to approximate level (Figure 17)

FIGURE 17


U-HEAD SCREW JACK
COLUMN
FRAME
COUPLING PIN
BRACE STUD
SILL
ADJUSTABLE SCREW JACK

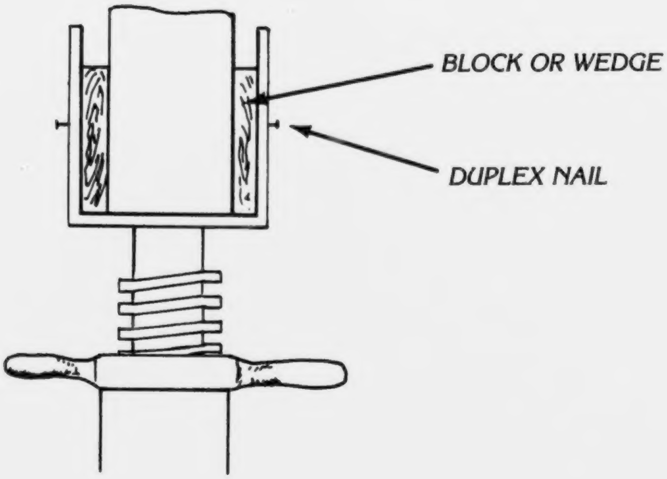
JOB SHEET #1

B. Install stringers

1. Lay stringers in U-head

   (NOTE: If stringers are not as wide as the U-head, block both sides so that stringer is centered. See Figure 18.)

FIGURE 18



2. Nail stringers to predrilled U-head, using duplex nails

C. Set up shore scaffold on next column line as outlined in steps A and B

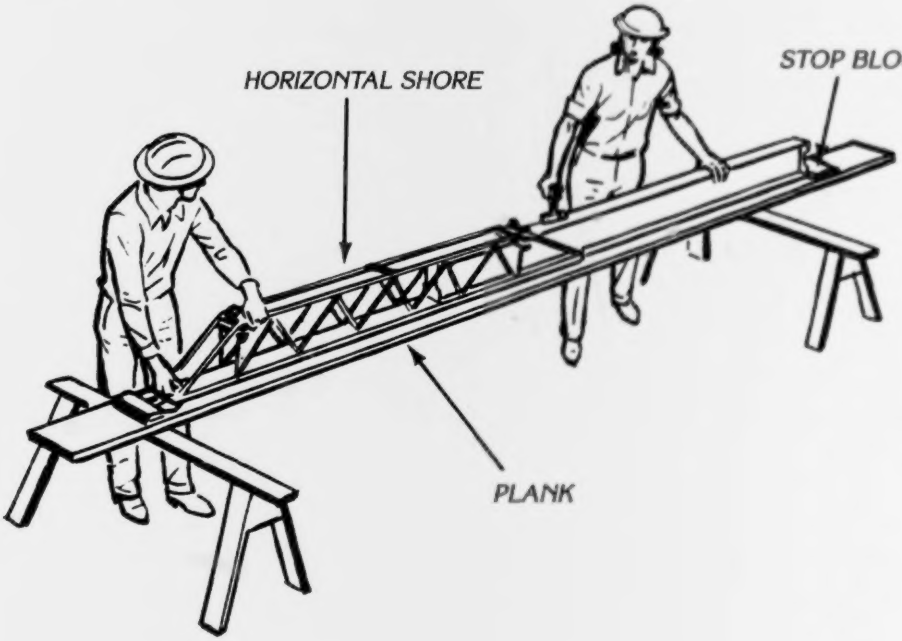
D. Install horizontal shores

JOB SHEET #1

1. Make jig for adjusting shores (Figure 19)

   (NOTE: A light template with blocks nailed on each end may also be used to adjust the shores.)

FIGURE 19

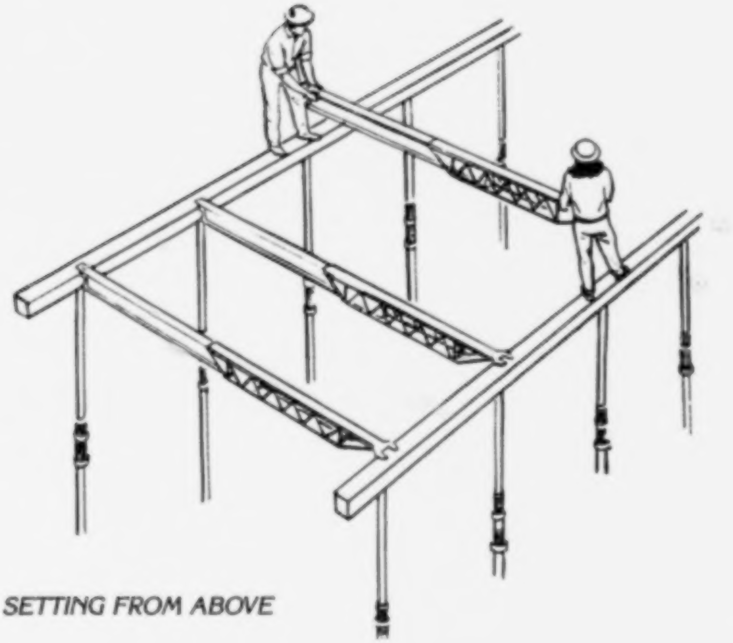


2. Adjust horizontal shores to proper length, and lock tightly
3. Determine joist spacing from structural plans and then lay out center line of structural joist on stringer
4. Wear safety belt when appropriate
5. Set horizontal shores, centering shore on layout mark

   (NOTE: Shores can be set from above or below. See Figures 20 and 21. Wear safety belt and take all necessary safety precautions.)

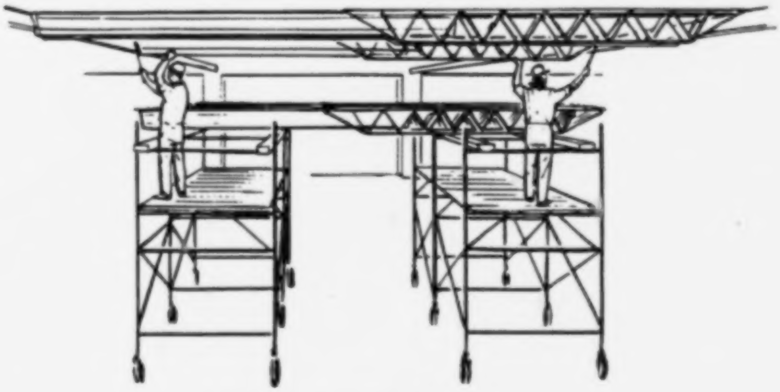
JOB SHEET #1

FIGURE 20



SETTING FROM ABOVE

FIGURE 21



ROLLING TOWER METHOD

JOB SHEET #1

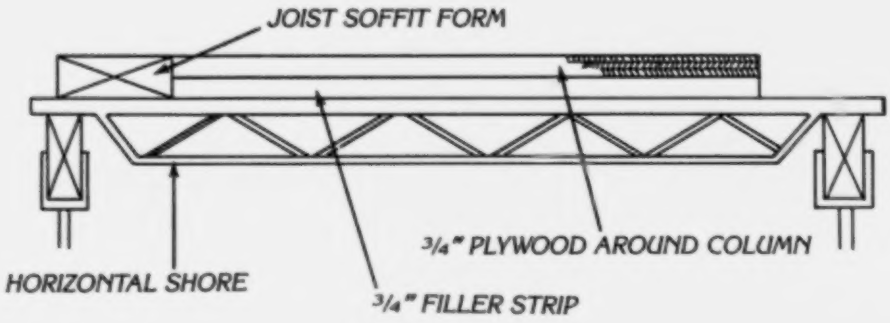
E. Install beam soffit

1. Lay 3/4-inch thick material on top of horizontal shores

2. Nail plywood to 3/4-inch strips (Figure 22)

   (NOTE: Horizontal shores might have to be set closer together in the beam area. Let plywood extend past side of beam to support one flange of the dome.)

FIGURE 22


JOIST SOFFIT FORM
3/4" PLYWOOD AROUND COLUMN
HORIZONTAL SHORE
3/4" FILLER STRIP

F. Install domes

1. Snap chalk line on deck at sides of beam

2. Lay plank across horizontal shores at joist center lines

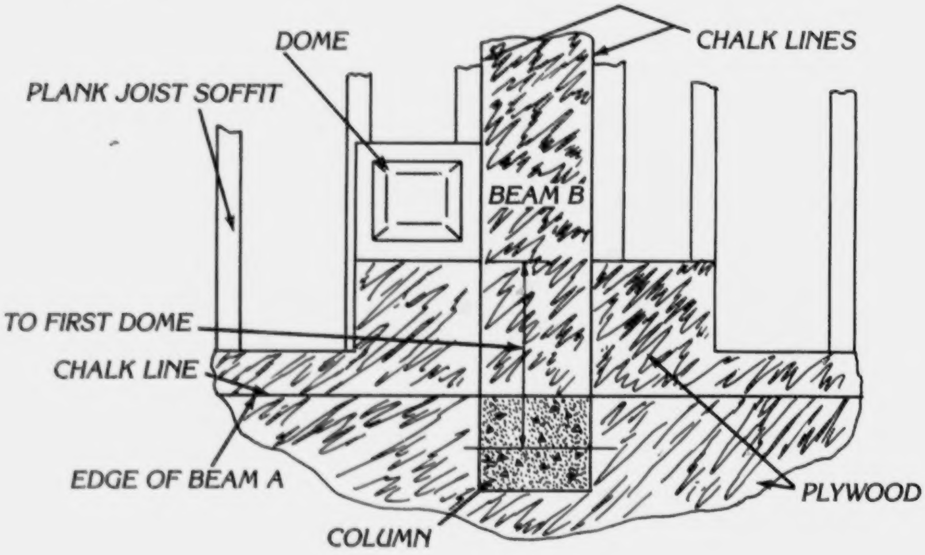
3. Measure from column center line to edge of first dome determined by shop drawings and place pencil mark at this point

JOB SHEET #1

4. Set first dome, aligning dome flange with chalk line on one edge, and placing pencil mark at adjoining edge (Figure 23)

   (NOTE: Solid decking may be used instead of the plank joist system.)

FIGURE 23


DOME
CHALK LINES
PLANK JOIST SOFFIT
BEAM B
TO FIRST DOME
CHALK LINE
EDGE OF BEAM A
PLYWOOD
COLUMN

5. Set second dome on chalk line and against first pan; nail to plywood and joist bottom form

   (NOTE: Check manufacturer's specifications for nailing and header instructions.)

6. Repeat step 5 to set all domes in this row

   (NOTE: Verify distance from last dome to center line of next beam to be the same as step 3 or per plan.)

7. Set second row of domes against flange and in line with flange joints of first row

   (NOTE: An additional dome might be added to this line to bring it to the side of beam A in Figure 23.)

8. Repeat step 7 to continue setting remaining rows of domes

9. Coat entire form surface with form oil

   (NOTE: Form oil must be applied before rebars are installed.)

JOB SHEET #1

G. Install perimeter beam side

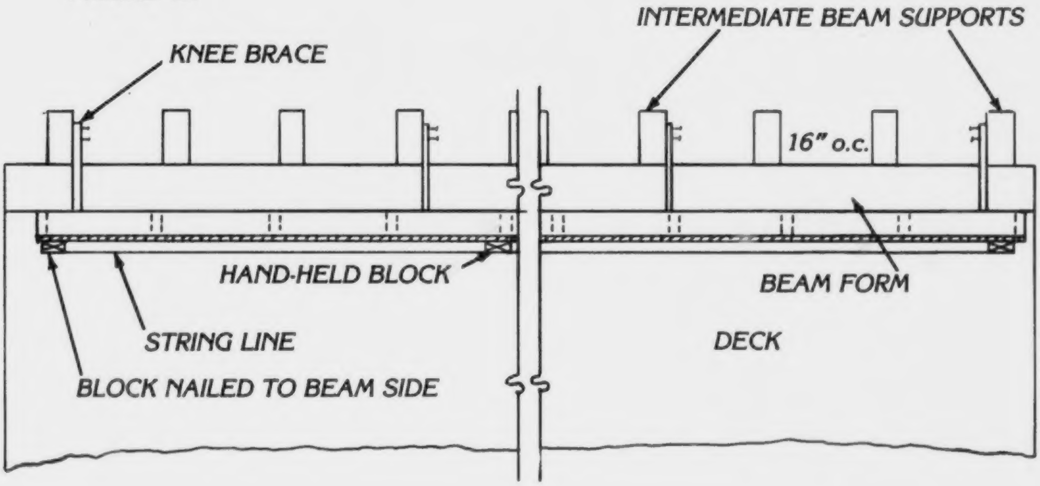
1. Build spandrel beam side

   (NOTE: The height of the beam side will be equal to the height of the dome plus the thickness of the slab.)

2. Coat form surface with form oil
3. Snap chalk line on plywood at outside of beam
4. Stand beam side on deck and nail deck after aligning bottom of form with chalk line
5. Nail knee brace from top of beam side to extended T-heads
6. Align top of beam side (Figure 24)

   (NOTE: Stretch string line over blocks to align top of form.)

FIGURE 24


INTERMEDIATE BEAM SUPPORTS
KNEE BRACE
16" o.c.
HAND-HELD BLOCK
BEAM FORM
STRING LINE
DECK
BLOCK NAILED TO BEAM SIDE

PLAN VIEW

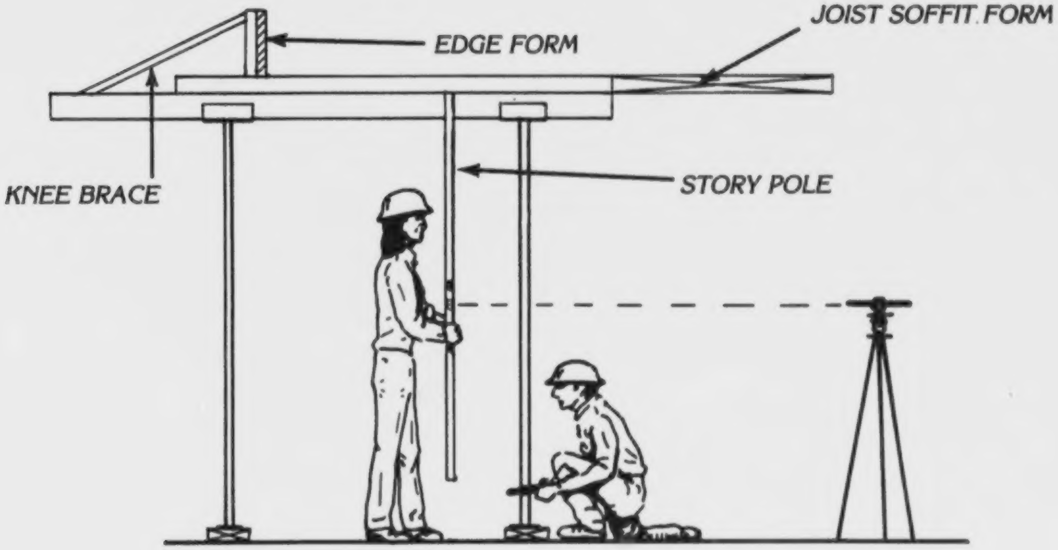
H. Check elevation of deck

1. Set up transit level on floor below deck
2. Establish height of instrument (HI)
3. Make a story pole to correspond with elevation at bottom of deck

JOB SHEET #1

4. Adjust upper or lower screw legs on scaffolds to obtain correct elevation (Figure 25)

FIGURE 25



I. Install bulkhead

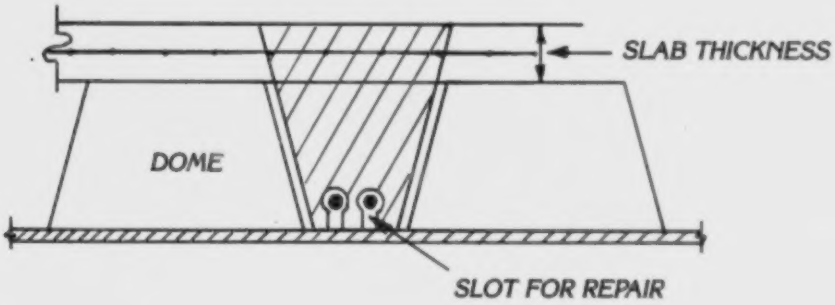
(NOTE: If entire floor can not be poured at one time, a bulkhead must be installed. If location is not given in the plans or specifications, check with your supervisor or instructor for permissible location.)

1. Place a 2×4 under wire mesh on end of pour
2. Anchor pans using method recommended by manufacturer
3. Lay 2×4 on top of mesh and first 2×4
4. Wedge upper 2×4 to proper elevation

JOB SHEET #1

5. Cut tapered pieces of plywood for joist area (Figure 26)

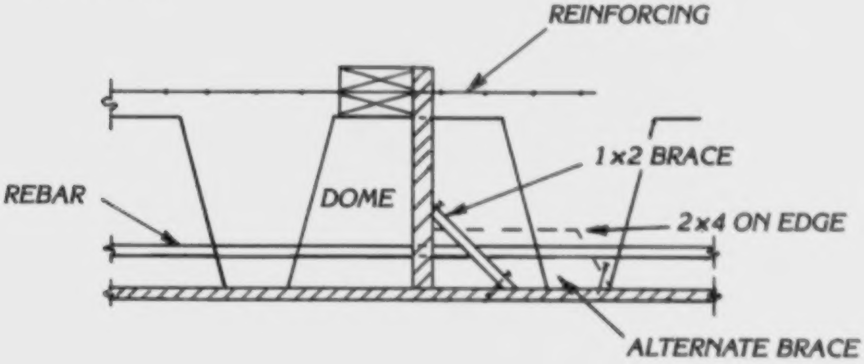
FIGURE 26


SLAB THICKNESS
DOME
SLOT FOR REPAIR

6. Nail plywood pieces to upper 2×4s

7. Brace bottom of plywood bulkhead (Figure 27)

FIGURE 27


REINFORCING
1×2 BRACE
REBAR
DOME
2×4 ON EDGE
ALTERNATE BRACE

J. Check work for accuracy and soundness

K. Clean work area and return equipment and materials to proper storage

ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

JOB SHEET #2 — CONSTRUCT FORMS FOR A ONE-WAY JOIST SYSTEM

I. Equipment and materials

  A. Claw hammer

  B. Handsaw

  C. Power handsaw and extension cord

  D. Thirty-inch hand level

  E. Chalk line

  F. Square

  G. Folding rule or steel tape

  H. Builders level

  I. 2×8s or larger for sills

  J. Patented shores

  K. Long forms

  L. 2×6s or 2×8s for joist soffit form

  M. Plywood deck

  N. 2×10s for joist

  O. 4×6s for shore head

  P. Form oil

  Q. 16d duplex and 6d common nails

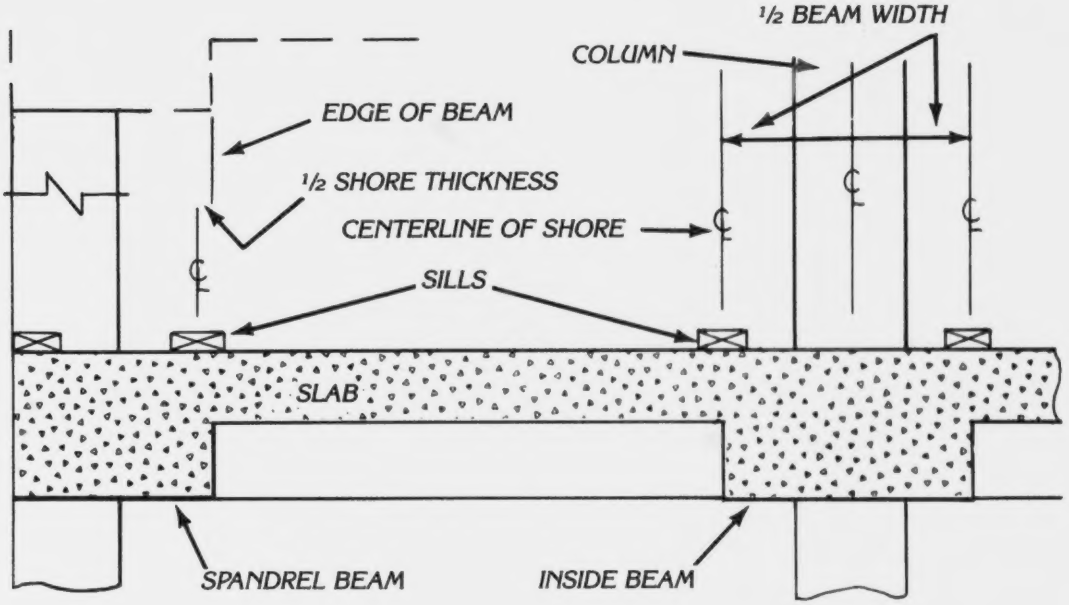
II. Procedure

  A. Erect shores and joists

JOB SHEET #2

1. Lay sills on deck (Figure 28)

FIGURE 28


½ BEAM WIDTH
COLUMN
EDGE OF BEAM
½ SHORE THICKNESS
CENTERLINE OF SHORE
SILLS
SLAB
SPANDREL BEAM
INSIDE BEAM

2. Secure two shores to shore head, making sure that shore center lines correspond with sill center line (Figures 29 and 30)

FIGURE 29

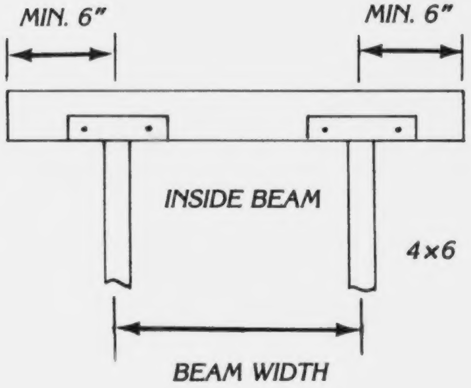
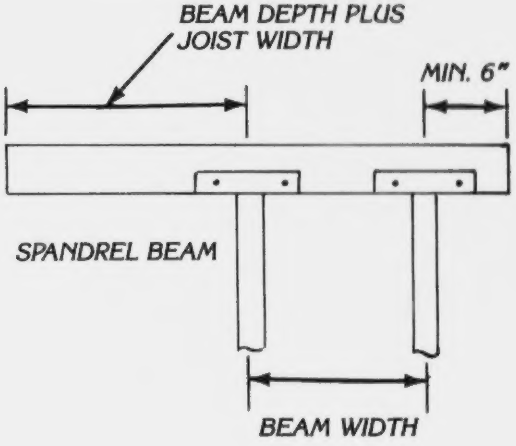

MIN. 6"
MIN. 6"
INSIDE BEAM
4×6
BEAM WIDTH

FIGURE 30


BEAM DEPTH PLUS
JOIST WIDTH
MIN. 6"
SPANDREL BEAM
BEAM WIDTH

JOB SHEET #2

3. Stand first shore unit upright 1 foot from column

4. Brace unit plumb in both directions

5. Nail base plates to sill

6. Stand second unit upright at end of joist

7. Brace unit plumb in both directions

8. Nail center joist to shore heads

9. Snap a chalk line on shore heads at both sides of beam

10. Nail remaining joists to shore heads, nailing edge joist accurately on inside of chalk line

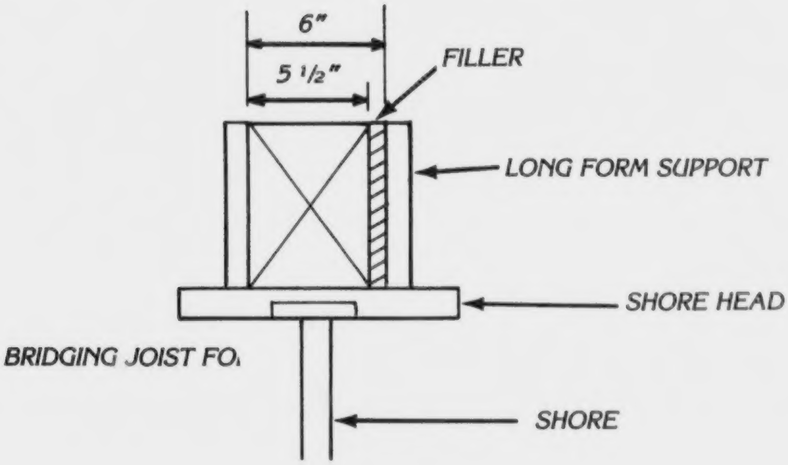
11. Install bridging joist bottom forms

    (NOTE: Bridging joists are placed at the end of long forms that are not adjacent to beams.)

    a. Frame stringers to exact width of bridging joist (Figure 31)

       (NOTE: The stringer may be ripped or a filler added to attain correct width. It may also be laminated.)

FIGURE 31



JOB SHEET #2

b. Secure short shore heads to single shore (See Figure 31)

c. Stand T-shores on sill to support each end of stringer, and brace plumb in both directions

d. Nail stringer to shore heads

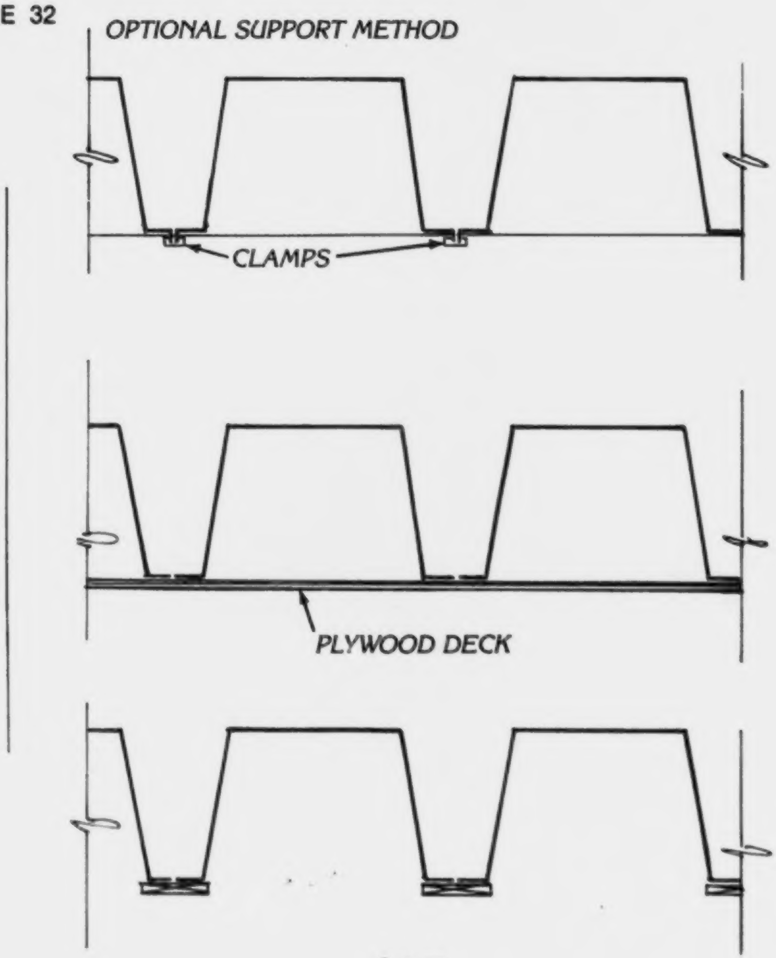
e. Install intermediate shores

f. Repeat steps a through e to continue erection of all bridging joist bottoms

B. Install all long form supports and the ones at bridging joist; nail long form support to stringer (Figure 32)

(NOTE: Material should be the same width as the stringer. See Figure 31. Use clamps recommended and furnished by the manufacturer.)

FIGURE 32

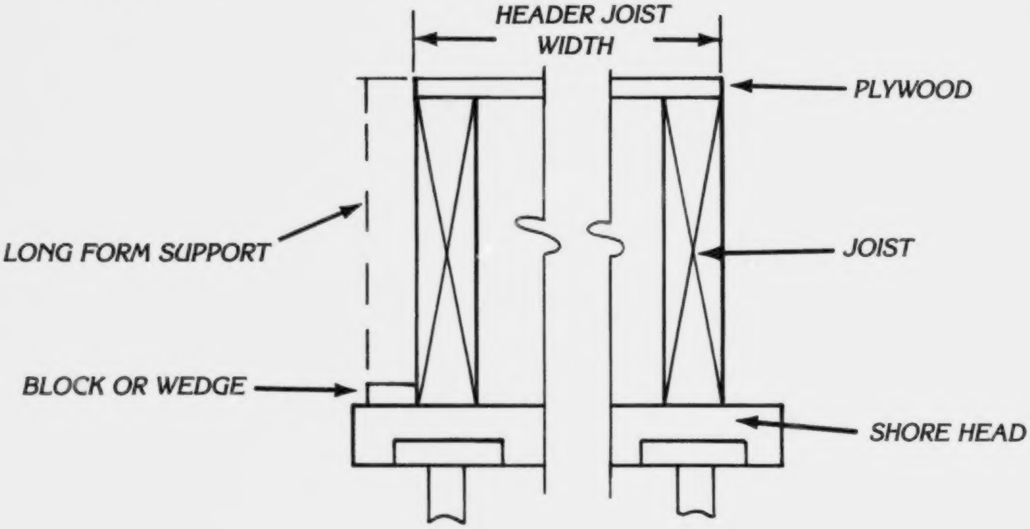


JOB SHEET #2

C. Install beam soffit form material and long form supports

1. Fabricate plywood to exact width of beam (Figure 33)

FIGURE 33


HEADER JOIST WIDTH
PLYWOOD
LONG FORM SUPPORT
JOIST
BLOCK OR WEDGE
SHORE HEAD

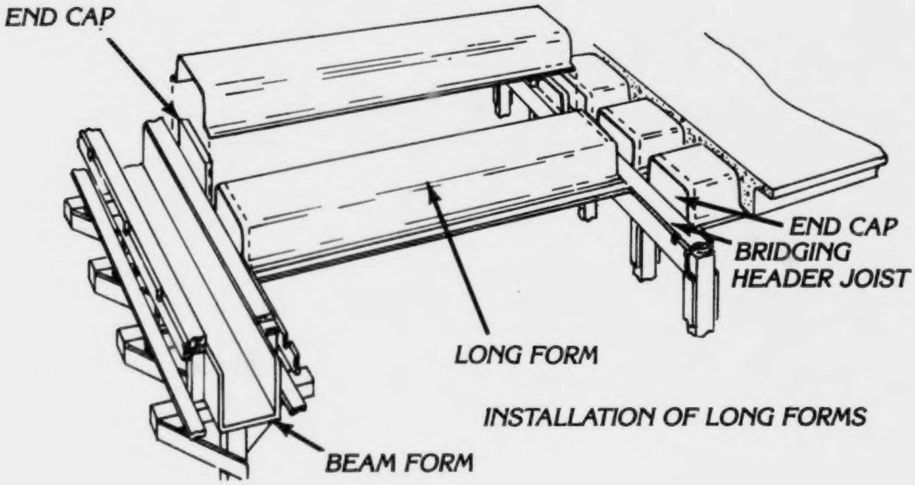
2. Nail plywood to joist

3. Nail long form supports to joist; if necessary, block long form support as shown in Figure 33 to bring top flush with plywood

JOB SHEET #2

D. Install long forms (Figure 34)

FIGURE 34



INSTALLATION OF LONG FORMS

1. Nail end caps to support
2. Set long form over end cap
3. Nail flange to form support, following manufacturer's installation instructions
4. Repeat steps 1 through 3 to continue setting remainder of long forms

E. Apply form oil to all surfaces exposed to concrete

(NOTE: Rebar will be installed after form oil has been applied.)

F. Check work for accuracy and soundness

G. Clean work area and return equipment and materials to proper storage

ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

JOB SHEET #3 — STRIP A TWO-WAY JOIST FORM SYSTEM (WAFFLE)

I. Equipment and materials

   A. Claw hammer

   B. Wrecking bar, 24-inch or larger

   C. Air compressor, 100 to 125 psi

   D. Air hose

   E. Air gun

      (NOTE: The air gun should be furnished by the dome manufacturer.)

   F. Form oil recommended by dome manufacturer

   G. Burlap

II. Procedure

   (NOTE: Steel dome systems are stripped in a similar manner.)

   A. Lower shore scaffold by loosening either upper or lower screws

      (NOTE: Lower scaffold only after concrete has reached its designed stripping strength.)

   B. Loosen horizontal shore lock bolt

   C. Insert wrecking bar between stringer and end plate

   D. Telescope shore until it clears stringer

   E. Lower shore with other end still on stringer and tighten lock nut

      (NOTE: Leave end on stringer and tighten lock nut to prevent further telescoping and potential injury.)

   F. Insert wrecking bar between stringer and end plate and pry out second end of horizontal shore

   G. Repeat steps B through F to continue removing horizontal shores

JOB SHEET #3

CAUTION

Center of joist bottoms might be loosened during this period. Watch for loose members and remove them immediately. Check with engineer or supervisor for reshore spacing if required.

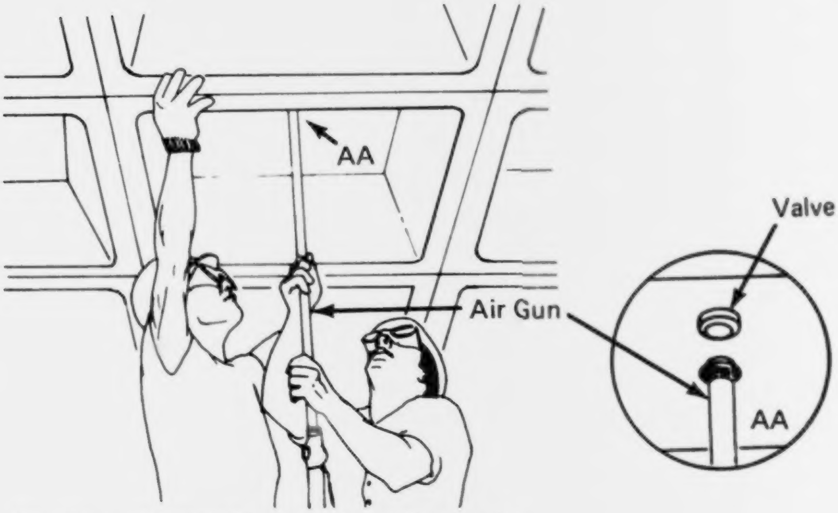
H. Strip all remaining joist bottom forms and beam bottom forms

I. Remove domes

1. Blow out domes with air gun (Figure 35)

   (NOTE: Never pry on flange of dome forms. Domes have special valves in top for insertion of air gun.)

   FIGURE 35



Courtesy of CECO Steel Products Corporation

2. Check for the following problems if dome does not pop out

   a. *Air not going through stripping valve* — Center punch stripping plug with nail or sharp rod and try to blow out again

   b. *Attachment to dome top* — Make sure rivets or pins have been pulled or that special attachment fastenings are loose

   c. *Excessive grout seepage under flange* — Chip concrete away with a hammer

   d. *Concrete-encrusted forms* — Do not strip well so do not let them get that way

JOB SHEET #3

J. Clean domes

1. Scrape off any concrete on forms
2. Scrub domes with burlap saturated with form oil

   (NOTE: Follow manufacturer's recommendation as to type of form oil.)

3. Make a neat pile of the forms

   (NOTE: Do not throw domes; this will damage them. Follow manufacturer's recommendations for stacking.)

K. Clean work area and return equipment and materials to proper storage

ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

JOB SHEET #4 — SET CONCEALED VOID TUBES

I. Equipment and materials

- A. Claw hammer
- B. Chalk line
- C. Electric drill motor, 1/4" or 3/8"; drills; and extension cord
- D. Side-cut pliers
- E. Folding rules or steel tape
- F. Void tubes
- G. End caps
- H. Tie-down spacers
- I. #12 annealed wire
- J. Slab bolsters
- K. 8d and 16d duplex nails

II. Procedure

(NOTE: The deck has been erected as for a flat slab.)

A. Drill holes for tie-down wires

1. Determine suggested spacing of tie-downs from Table 1

TABLE 1

6" to 11" O.D. . . . 5′ on center	18.7" to 24.8" O.D. . . . 3′ on center
12" to 18.7" O.D. . 4′ on center	24.8" to 36.9" O.D. . . . 2′ on center

2. Locate first tie-down (Figure 36, Step 1)

(NOTE: The first row of tie-downs should be not over one-half the table spacing from the end of the tube.)

JOB SHEET #4

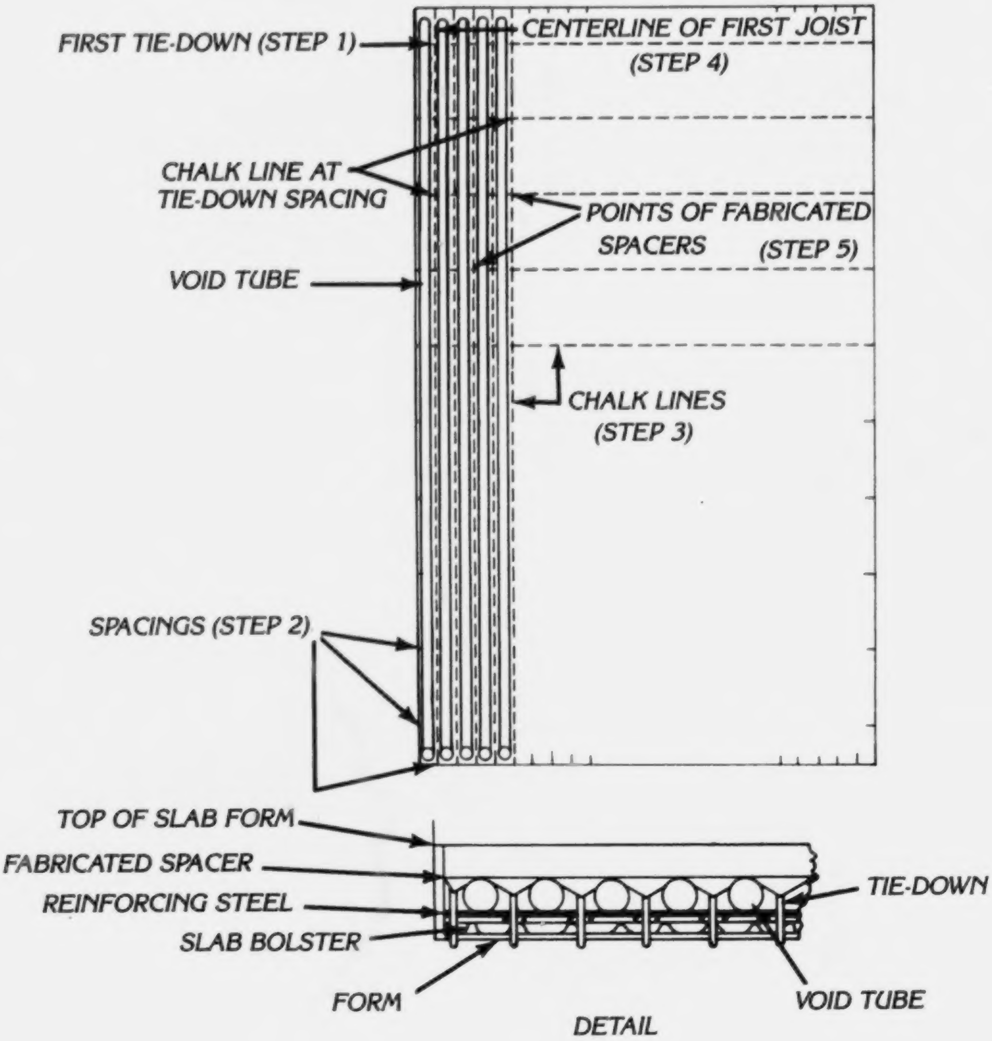
3. Lay out all spacing along length and at each end of void tube (Figure 36, Step 2)

4. Snap a chalk line to join layout points (Figure 36, Step 3)

5. Locate and snap a chalk line at center line of first joist (Figure 36, Step 4)

6. Lay fabricated spacer alongside chalk line, with points at center line of joist (Figure 35, Step 5)

FIGURE 36


FIRST TIE-DOWN (STEP 1)
CENTERLINE OF FIRST JOIST (STEP 4)
CHALK LINE AT TIE-DOWN SPACING
POINTS OF FABRICATED SPACERS (STEP 5)
VOID TUBE
CHALK LINES (STEP 3)
SPACINGS (STEP 2)
TOP OF SLAB FORM
FABRICATED SPACER
REINFORCING STEEL
SLAB BOLSTER
TIE-DOWN
FORM
VOID TUBE
DETAIL

JOB SHEET #4

7. Drill holes through deck at points of fabricated spacer

8. Repeat steps 6 and 7 to drill remaining holes

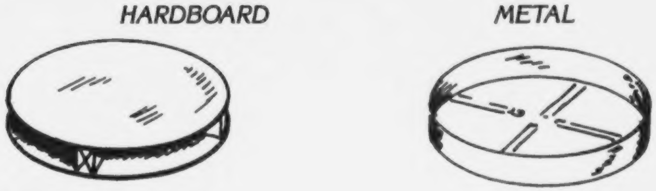
   (NOTE: Bottom rebars should be installed at this time.)

B. Set and anchor void tubes

1. Attach end closures to void tube (Figure 37)

   (NOTE: End enclosures can be made of wood or obtained from the manufacturer.)

FIGURE 37

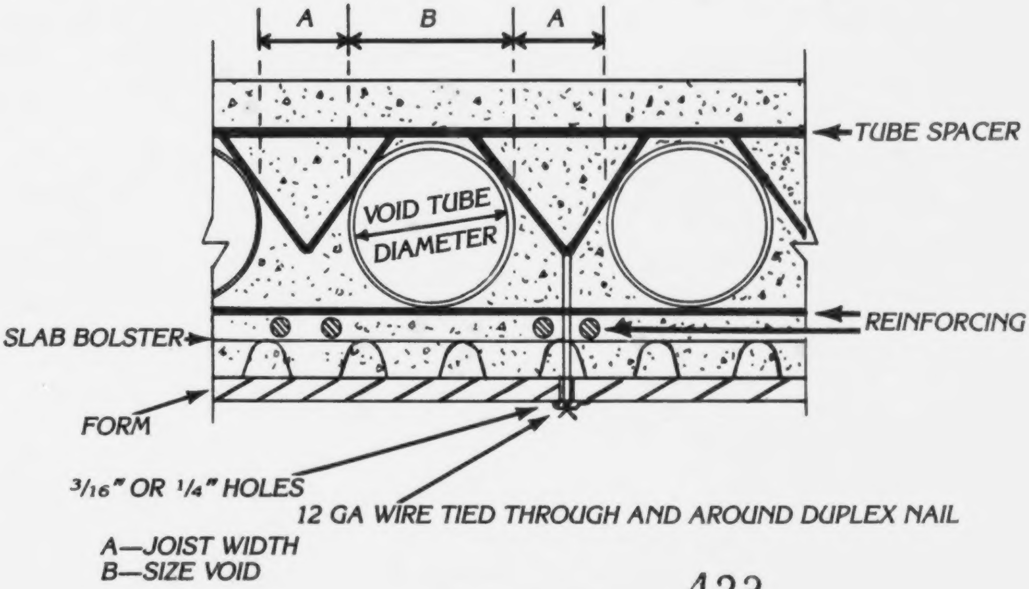

HARDBOARD
METAL

2. Lay void tubes on rebars

3. Install spacer on void tubes (Figure 38)

   (NOTE: Void spacers are tied down to avoid the possibility of the tubes floating out of the slab.)

FIGURE 38 *DETAILS OF A METOD FOR SPACING AND TIE-DOWN*


A
B
A
TUBE SPACER
VOID TUBE DIAMETER
REINFORCING
SLAB BOLSTER
FORM
3/16" OR 1/4" HOLES
12 GA WIRE TIED THROUGH AND AROUND DUPLEX NAIL
A—JOIST WIDTH
B—SIZE VOID

JOB SHEET #4

4. Cut wire to proper length

   (NOTE: See Figure 38, which illustrates tie wire installation.)

5. Secure tie-down with precut wire as shown in Figure 38

   (NOTE: Tie-down wire is looped over tie-down spacer and both ends are inserted in a predrilled hole in the deck and secured to a duplex nail driven into the underside of the deck.)

C. Check work for accuracy and soundness

D. Clean work area and return equipment and materials to proper storage

ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

JOB SHEET #5 — SET SCREEDS ON A DECK FOR FLAT SLAB

I. Equipment and materials

  A. Folding rule or steel tape

  B. String line

  C. Claw hammer

  D. Builder's level and rod

  E. Adjustable screed chairs

  F. Screed pipe or steel bar (depending on type of chairs used)

  G. 8d duplex nails

II. Procedure

  A. Establish screed location (See Figure 39.)

    1. Measure across one end of forms to determine width of pour (48′ – 0″)

    2. Divide area into four equal parts (12′ – 0″)

    3. Mark location of each run of screeds on form at each end of pour

  B. Set a nail at each mark on the forms

  C. Attach string line in a straight line from nail on one form to nail on opposite form

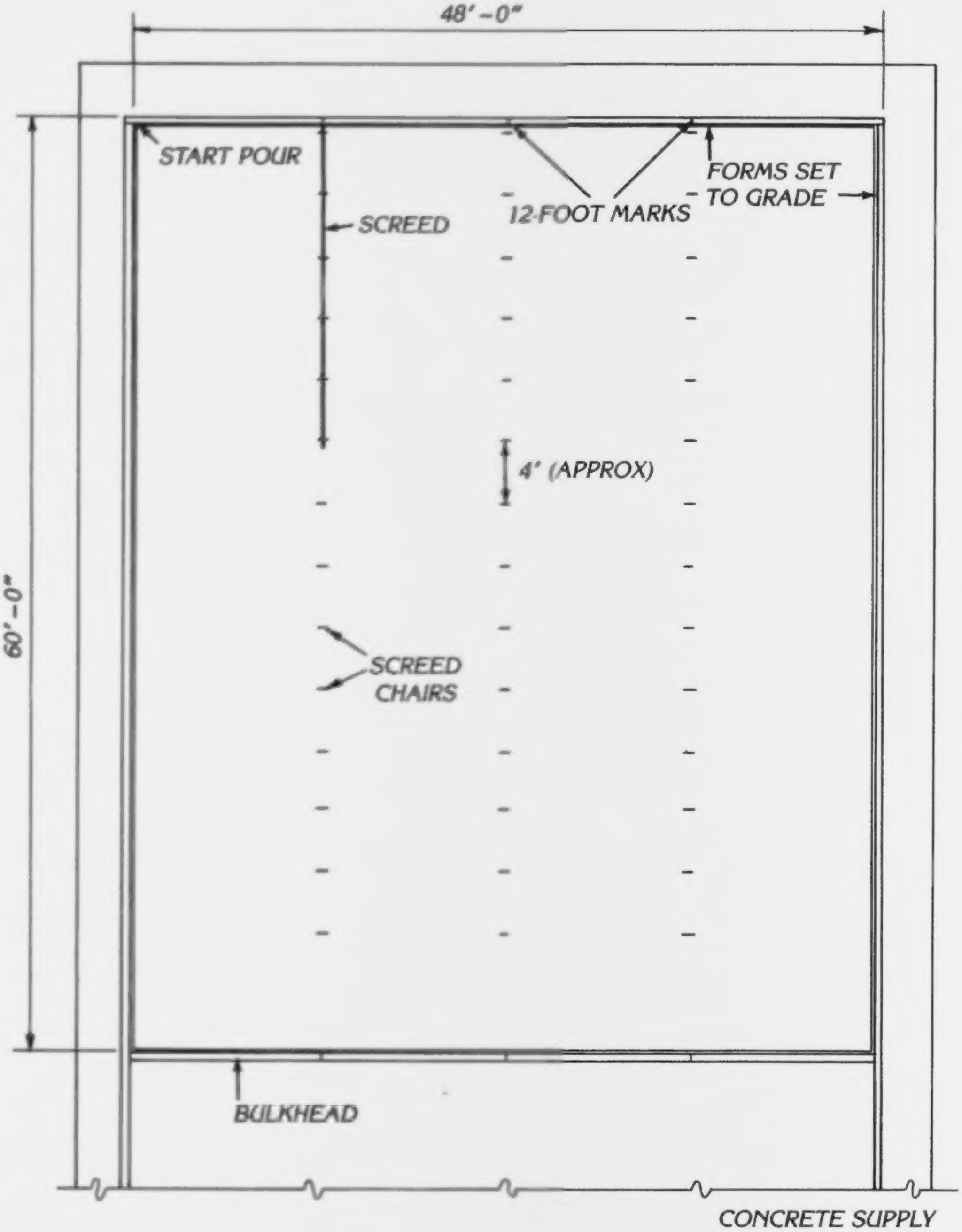
  (NOTE: This line is used as a guide to set chairs in a straight line.)

  D. Starting at one end, nail screed chairs to deck approximately 4 feet apart

  (NOTE: The distance between the chairs will vary according to the size of the screed pipe or bar. The screed needs to be closer together if using small-diameter pipe or small bar.)

JOB SHEET #5

FIGURE 39


48'-0"
60'-0"
START POUR
SCREED
12-FOOT MARKS
FORMS SET TO GRADE
4' (APPROX)
SCREED CHAIRS
BULKHEAD
CONCRETE SUPPLY

(NOTE: Screed will be moved along as pour progresses and screed chairs will be removed after screed has been moved forward.)

JOB SHEET #5

E. Set-up builder's level and establish grade

F. Use level and rod to set grade on each screed chair

(NOTE: The grade on the chairs is accomplished by screwing the top part of the chair up or down until it is at the desired grade. See Figure 40 and 41.)

FIGURE 40

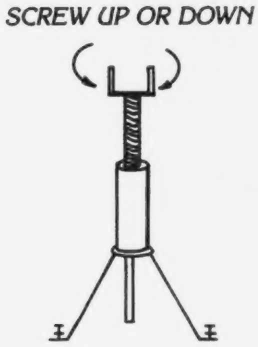
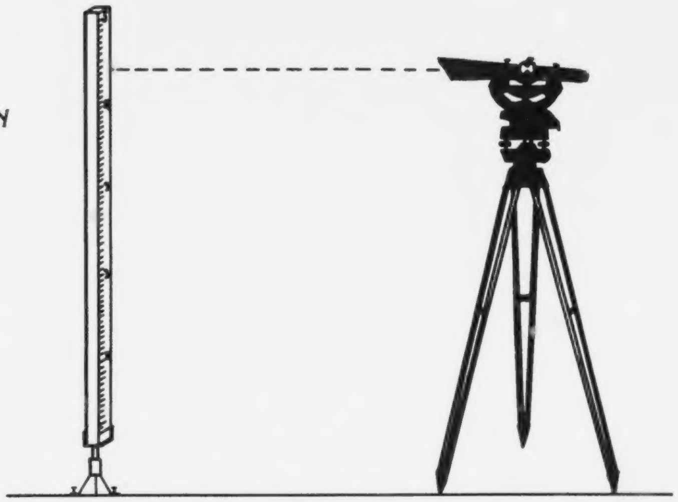


FIGURE 41



G. Continue setting and leveling all screed chairs, using procedures in Step F

H. Spot check grade by placing screed in chairs and taking shots at various points

I. Made adjustments as necessary

J. Clean work area and return equipment and materials to proper storage

ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

TEST

NAME ______________________________ SCORE ______________

1. Match to their correct definitions terms associated with above-grade slab systems. Write the correct numbers in the blanks.

______a. Prop placed against or beneath an object for support

______b. Piece of heavy material placed across several shores; horizontal or inclinced supporting member

______c. Single or multistrand of high tensile wire or a rod used to stress concrete

______d. Process of introducing internal stresses after concrete has reached a predetermined strength

______e. Horizontal board used to hold shores in alignment and to restrict lateral movement

______f. Single section of manufactured form used to mold exposed voids in a one-way joist system

______g. Manufactured tube of metal or fiber used to create concealed voids in slabs

______h. Framing for pans and domes comprised of joist soffit forms and headers

______i. Horizontal sheathing that supports wet concrete

______j. Manufactured product that forms an exposed void in a waffle slab system

______k. Slab design in which concrete is poured on domes; two-way joist system

______l. System whereby a large section of slab form is removed with a crane and moved to the next pour location

______m. Horizontal timber laid directly on ground or floor to support a frame structure

1. Void tube
2. Stringer
3. Pan
4. Ribbon
5. Post-tensioning
6. Tendon
7. Shore
8. Flying form
9. Dome
10. Open centering
11. Waffle
12. Deck
13. Mud sill

TEST

2. Identify the parts of the slab forming system illustrated below. Write the corect numbers in the blanks.

_____a. Shore

_____b. Joist soffit form

_____c. Header

_____d. Deck

_____e. Stringer

_____f. Mud sill

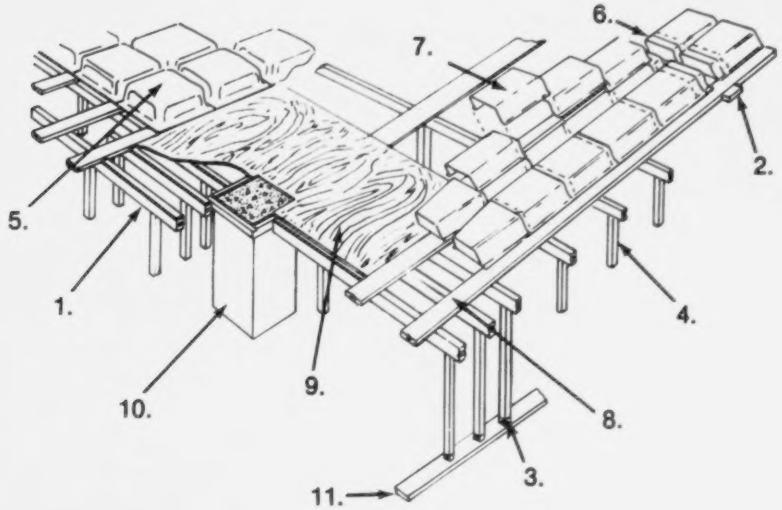
_____g. Dome

_____h. Pan

_____i. Wedge

_____j. End cap

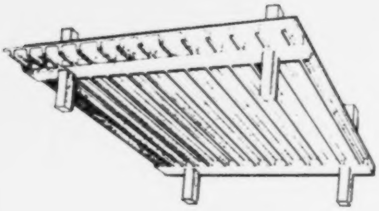
_____k. Column form



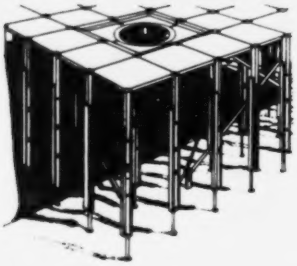
3. Identify the following types of forming systems. Write the correct names in the blanks.

One-way joist sytem
Permanent or stay-in-place system
Filigree system
Flat slab system
Flat slab with drophead
Two-way joist system

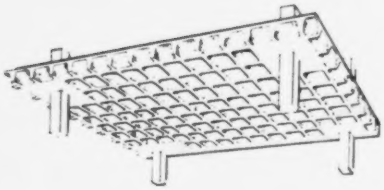
TEST



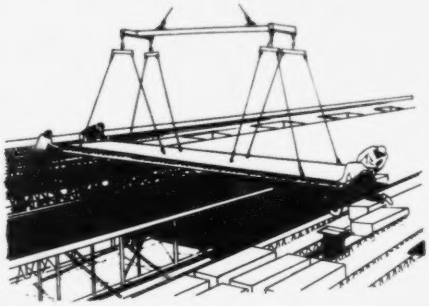
a. ______________________________



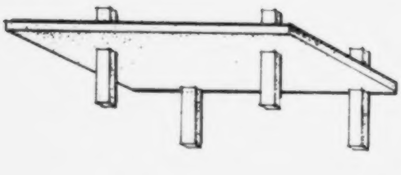
b. ______________________________



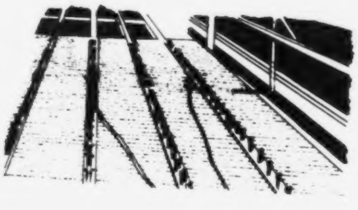
c. ______________________________



d. ______________________________



e. ______________________________



f. ______________________________

TEST

4. Select from the following list materials used to construct pans and domes. Write an "X" in the blank before each correct answer.

_____a. Insulation board

_____b. Molded fiber (wood or paper)

_____c. Stainless steel

_____d. Molded fiberglass

_____e. Wood

_____f. Rubberized fabrics

_____g. Metal

5. List five types of materials used for permanent forms.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

6. List three types of materials used to form concealed voids and ducts in concrete.

a. ______________________________

b. ______________________________

c. ______________________________

7. Name types of manufactured exposed void forms.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

TEST

(NOTE: Test question 8 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.

8. Demonstrate ability to
   - a. Construct forms for a two-way joist system.
   - b. Construct forms for a one-way joist system.
   - c. Strip a two-way joist form system (waffle).
   - d. Set concealed void tubes.
   - e. Set screeds on a deck for a flat slab.

ABOVE-GRADE SLAB SYSTEMS
UNIT VIII

ANSWERS TO TEST

1. a. 7
   b. 2
   c. 6
   d. 5
   e. 4
   f. 3
   g. 1
   h. 10
   i. 12
   j. 9
   k. 11
   l. 8
   m. 13

2. a. 4
   b. 8
   c. 2
   d. 9
   e. 1
   f. 11
   g. 5
   h. 7
   i. 3
   j. 6
   k. 10

3. a. One-way joist system
   b. Flat slab with drophead
   c. Two-way joist (waffle)
   d. Filigree system
   e. Flat slab
   f. Permanent or stay-in-place

4. b, d, e, g

5. Answer should include any five of the following

   a. Metal
   b. Precast concrete
   c. Wood
   d. Plastic
   e. Fiberboard
   f. Reinforced water-repellent corrugated paper
   g. Wire mesh with waterproof paper backing
   h. Insulation board
   i. Fabric

6. Answer should include any three of the following

   a. Laminated fiber tubes
   b. Steel spirally wound tubes
   c. Corrugated cardboard
   d. Inflatable rubber tubing
   e. Rubberized fabric
   f. Expanded polystyrene

ANSWERS TO TEST

7. a. Adjustable form
   b. Flange form
   c. Long form
   d. Dome form

8. Performance skills evaluated to the satisfaction of the instructor.

FIREPROOF ENCASEMENT FORMS
UNIT IX

UNIT OBJECTIVE

After completing this unit, the student should be able to identify parts of and construct fireproof encasement forms. The student will show this knowledge by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with fireproof encasement forms.
2. State the purpose of fireproof encasement.
3. List types of special hardware used to erect fireproof encasement forms.
4. Identify the parts of a fireproof encasement form.
5. List major differences between erection of fireproof encasement forms and erection of structural concrete forms.
6. Demonstrate the ability to construct fireproof encasement forms for columns and beams.

FIREPROOF ENCASEMENT FORMS
UNIT IX

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency masters

    1. TM #1 — Beam Hanger and Joist Soffit

    2. TM #2 — Parts of a Form

  D. Information Sheet

  E. Job Sheet #1 — Construct Fireproof Encasement Forms for Columns and Beams

  F. Test

  G. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Order or obtain materials planned to supplement unit.

    1. Examples of soffit spacers and beam hangers

    2. Equipment and materials for job sheet procedures

    3. Latest edition of *Modern Carpentry* by Willis H. Wagner

    4. Transparencies and competency profiles

    (NOTE: Transparencies and competency profiles for this manual are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E. Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

  C. Provide students with unit.

SUGGESTED ACTIVITIES

D. Introduce unit.

SUGGESTIONS:

- Discuss construction in which fireproof encasement forms are desirable.
- Discuss unit and specific objectives.

E. Discuss information and job sheets.

1. Use Information Sheet, Section I to introduce students to terms and definitions associated with fireproof encasement forms.
2. Use Information Sheet, Section II to discuss the purpose of fireproof encasement forms.
3. Use Information Sheet, Section III to introduce students to the types of special hardware used to erect fireproof encasement forms.

   SUGGESTIONS:

   - Use Transparency #1 to illustrate your discussion.
   - Show students examples of various soffit spacers and beam hangers.
   - Explain the reasons for using such hardware in construction of fireproof encasement forms.

4. Use Information Sheet, Section IV to introduce students to the parts of a fireproof encasement form.

   SUGGESTIONS:

   - Use Transparency #2 to illustrate your discussion.
   - Show students the actual parts on a prebuilt form, either in your shop or at a commercial construction site.

5. Use Information Sheet, Section V to discuss the major differences between erection of a fireproof encasement form and erection of structural concrete forms.

   SUGGESTIONS:

   - Demonstrate and discuss procedure outlined in Job Sheet #1.
   - Have students complete Job Sheet #1.

SUGGESTED ACTIVITIES

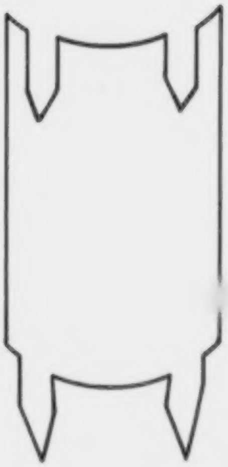
III. Unit references

A. Burke, Arthur E.; Dalzell, J. Ralph; and Townsend, Gilbert. *Architectural and Building Trades Dictionary*. Chicago, Illinois: American TEchnical Society, 1955.

B. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1979.

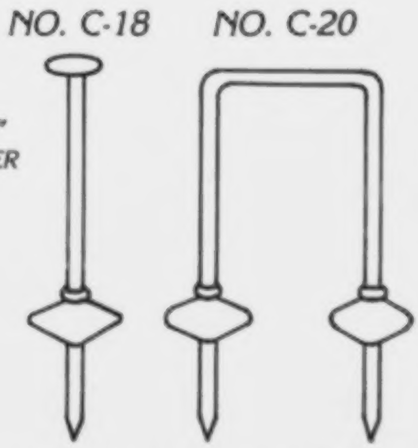
C. Smith, Ronald C. *Principles and Practices of Heavy Construction*. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1970.

Beam Hanger and Joist Soffit



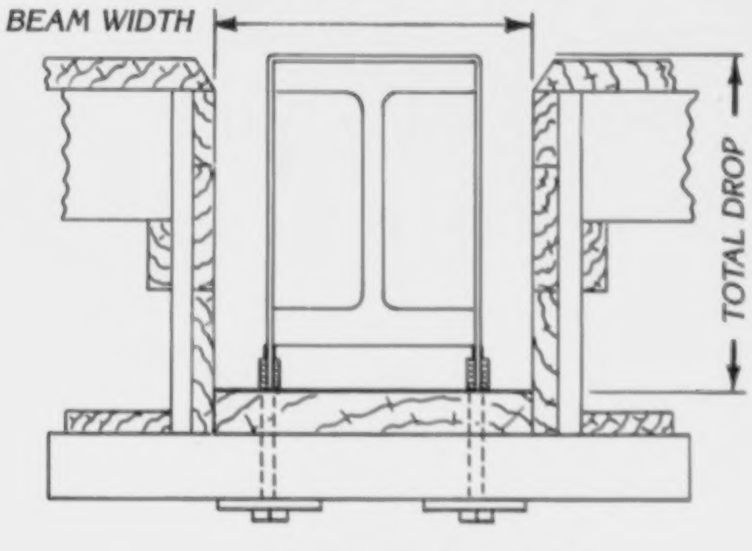
SOFFIT SPACER

MADE IN 1 ½", 2", AND 3" LENGTHS WITH HEIGHTS OVER 3" AVAILABLE.

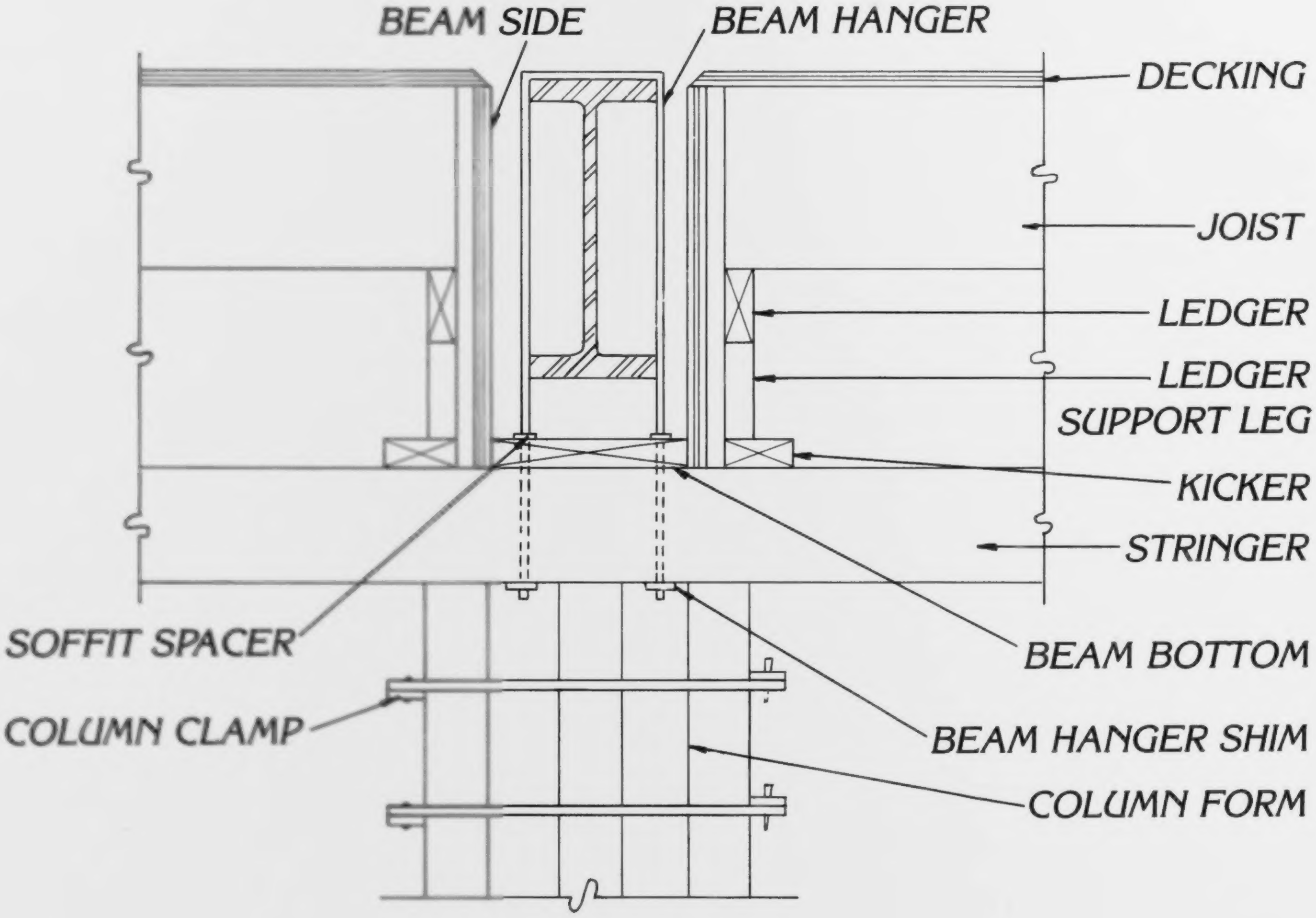

NO. C-18
NO. C-20

SINGLE AND DOUBLE SPACERS

SAME CONSTRUCTION AS STANDARD COIL TIE. WORK LOAD OF 3000 LBS. PER SIDE. FOR ½", 7500 LBS. FOR ¾", AND 10,000 LBS. FOR 1". ORDERED BY BEAM WIDTH, DIAMETER, AND TOTAL DROP.


BEAM WIDTH
TOTAL DROP

Parts of a Form


BEAM SIDE
BEAM HANGER
DECKING
JOIST
LEDGER
LEDGER SUPPORT LEG
KICKER
STRINGER
SOFFIT SPACER
BEAM BOTTOM
COLUMN CLAMP
BEAM HANGER SHIM
COLUMN FORM

FIREPROOF ENCASEMENT FORMS
UNIT IX

INFORMATION SHEET

I. Terms and definitions

  A. Fireproof encasement — Process of encasing structural steel members in concrete

  B. Brace — Piece of wood or other material that directs, resists, or supports weight or pressure

  C. Beam bottom — That part of a beam that supports vertical pressure

  D. Beam side — Stud frame and sheathing section that comprise vertical section of form

  E. Monolithic pour — Continuous mass of concrete cast as a single unit

  F. Beam hanger — Steel hanger that supports beam and slab forms

  G. Soffit spacer — Nut that is part of beam hanger

  H. Ledger — Horizontal board nailed to a form to support intersecting horizontal members

  I. Stringer — Piece of material placed across several shores; a horizontal or inclined supporting member

  J. Form oil — Paraffin oil or other manufactured product applied to form to prevent concrete from adhering to form

II. Purpose of fireproof encasement — To protect structural steel against deterioration caused by overheating

III. Special hardware used to erect fireproof encasement forms

  A. Beam hangers

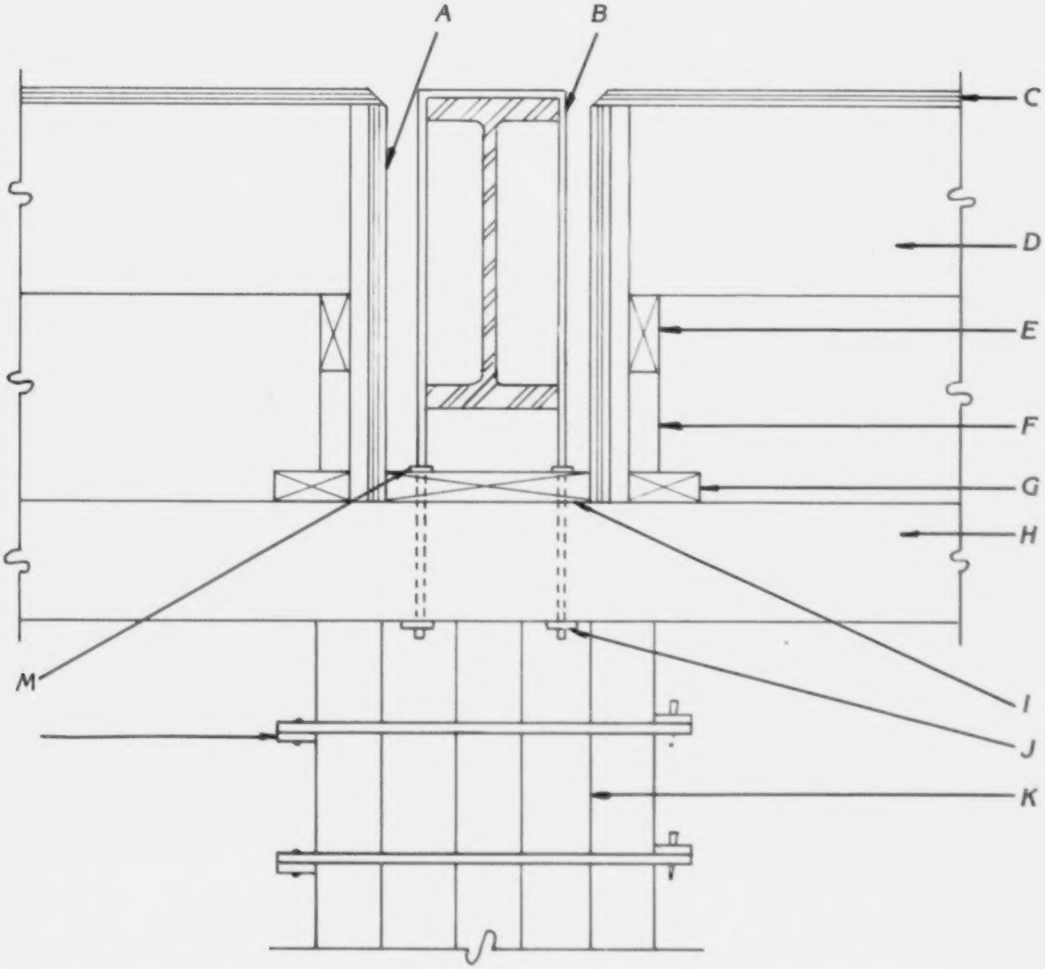
  B. Soffit spacers

INFORMATION SHEET

IV. Parts of a fireproof encasement form (Figure 1)

A. Beam side
B. Beam hanger
C. Decking
D. Joist
E. Ledger
F. Ledger support leg
G. Kicker
H. Stringer
I. Beam bottom
J. Beam hanger shim
K. Column form
L. Column clamp
M. Soffit spacer

FIGURE 1



INFORMATION SHEET

V. Major differences between erection of fireproof encasement forms and erection of structural concrete forms

   A. Through ties cannot be used on fireproof encasement forms

   B. Shores do not have to be used to support beam and slab forms for fireproof encasement

FIREPROOF ENCASEMENT FORMS
UNIT IX

JOB SHEET #1 — CONSTRUCT FIREPROOF ENCASEMENT FORMS FOR COLUMNS AND BEAMS

I. Tools and materials

A. Tools

1. Hammer
2. Handsaw
3. Power handsaw and extension cord
4. String line
5. Power drill motor
6. Drills, size of hanger
7. Eye protection
8. Powder-actuated fastener

B. Materials

1. Plywood sheathing
2. 4×4s for stringers
3. 2-inch thick material for beam bottom
4. 2×4s for studs, top plates, and kickers
5. 1×4s for bottom plates and cleats
6. Soffit spacers
7. Column clamps
8. 2×6s for ledgers
9. 2×4s for ledger support legs
10. Concrete nails or powder-actuated pins
11. 8d and 16d duplex nails

JOB SHEET #1

II. Procedure

(NOTE: Forms for structural concrete columns and beams are constructed very similarly.)

A. Put on eye protection

B. Lay out material

C. Determine size of beams and columns

D. Cut material to size

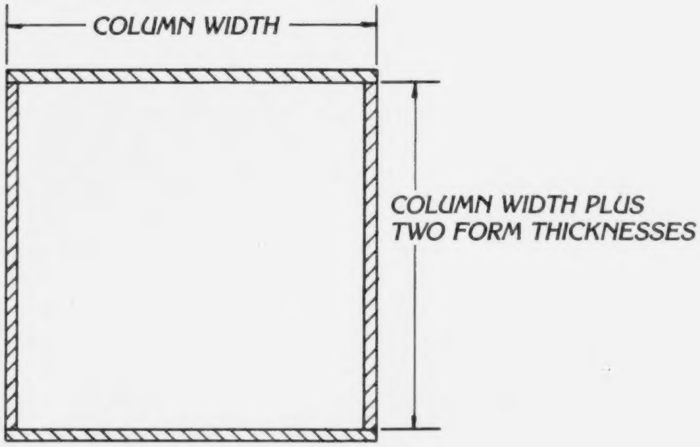
1. Cut stringers to length

   (NOTE: Stringer should extend past beam forms on each side to support deck and beam side kicker.)

2. Cut column plywood to size (Figure 2)

   (NOTE: The height of the column form will be the distance from the floor to the underside of the decking.)

FIGURE 2

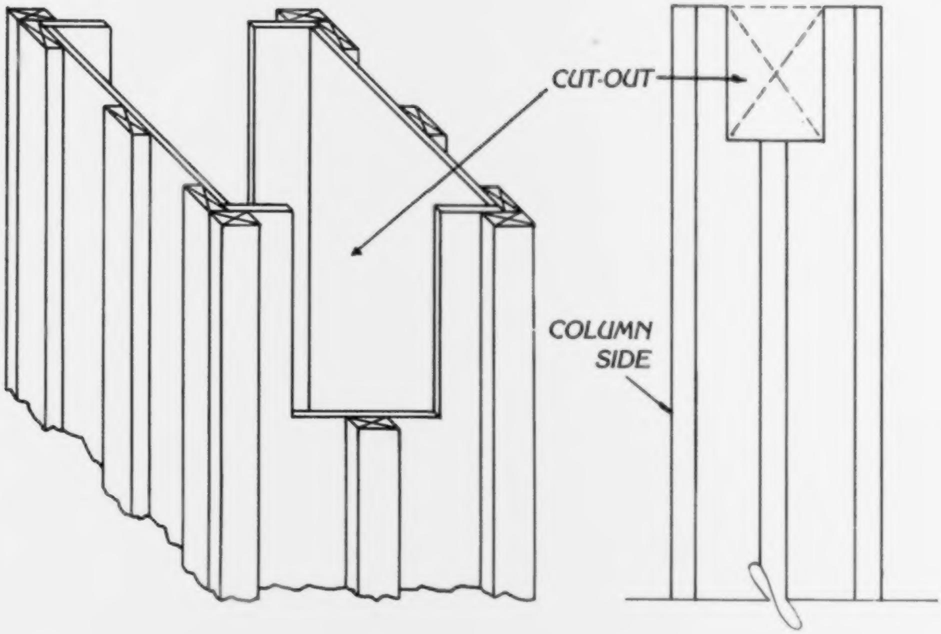


3. Cut out beam pocket in column side (See Figure 3.)

   (NOTE: The size of the beam pocket should show the beam bottom and beam sides to extend to the inside of the column form.)

JOB SHEET #1

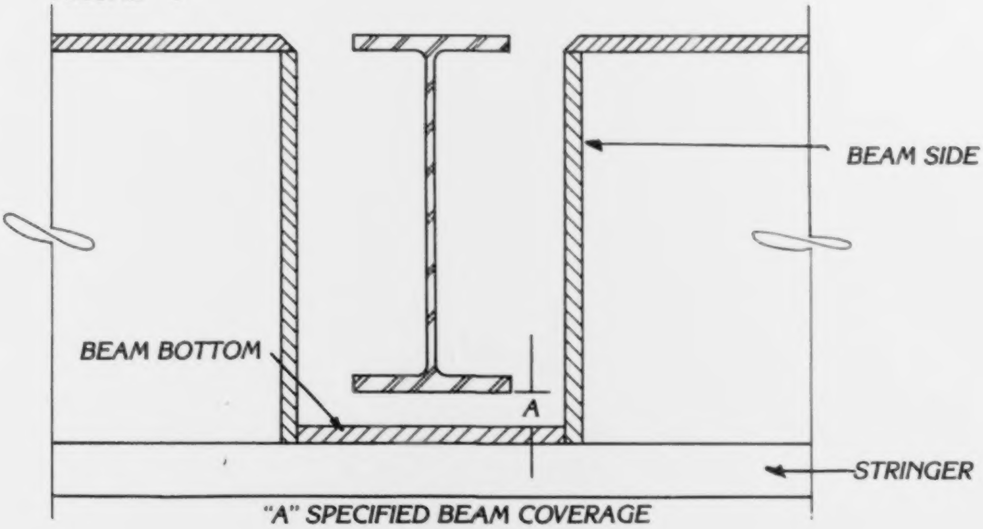
FIGURE 3


CUT-OUT
CUT-OUT
COLUMN SIDE

4. Cut beam plywood to size (Figure 4)

   (NOTE: The beam side should sit on the stringer and the decking should sit on the beam side.)

FIGURE 4


BEAM SIDE
BEAM BOTTOM
A
STRINGER
"A" SPECIFIED BEAM COVERAGE

5. Cut column and beam sides

6. Cut beam studs the height of the beam side minus the top and bottom plates

E. Assemble column and beam sides

1. Assemble the column sides as shown in Figures 5, 6, and 7

FIGURE 5

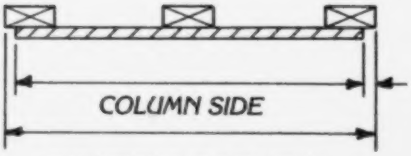

COLUMN SIDE
SHEATHING THICKNESS

FIGURE 6

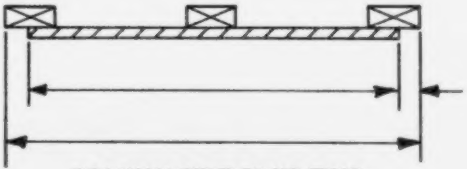
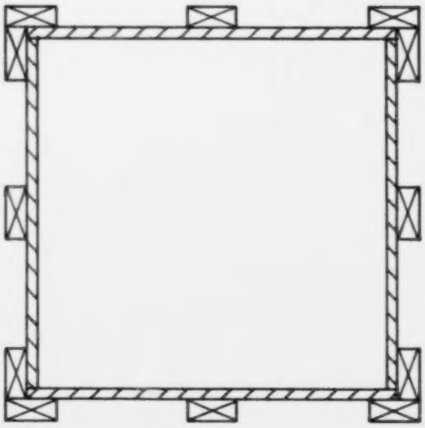

COLUMN SIDE PLUS TWO
SHEATHING THICKNESSES

FIGURE 7



2. Assemble the beam sides

   a. Lay out stud spacing on plate

   b. Nail studs to plates

   c. Nail sheathing to studs

F. Build beam bottom (Figure 10)

1. Select type of beam bottom to be constructed

   (NOTE: Beam bottom may be built with 2-inch solid material or with a built-up beam bottom of plywood and 2×4 runners. See Figures 8 and 9.)

JOB SHEET #1

EXAMPLES:

FIGURE 8

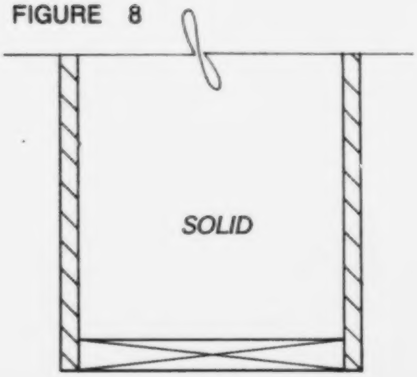
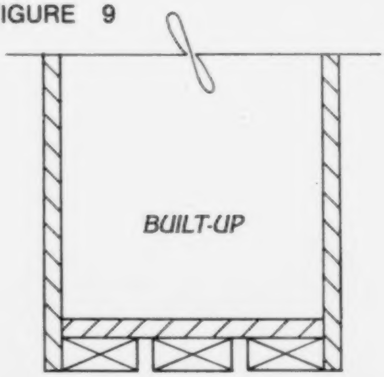
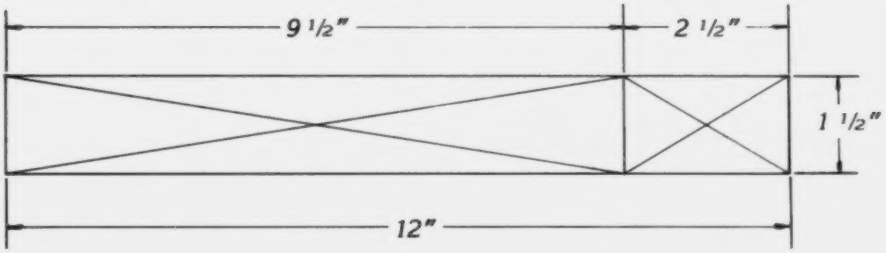


FIGURE 9



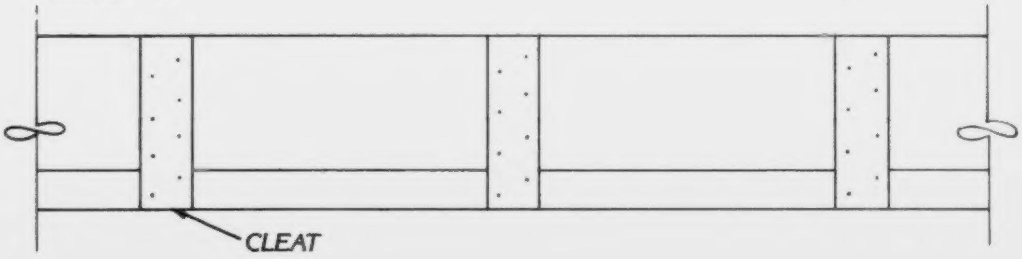
(NOTE: If a 2×4 is used to cut the 2 ½-inch piece, there will be 1-inch waste. Two pieces 2 ½-inches wide can be cut from a 2×6 with less than ½-inch waste for the two pieces.)

FIGURE 10



2. Cleat the pieces together, spacing cleats to miss beam hanger location (Figure 11)

FIGURE 11



3. Drill holes for hangers in beam bottom

4. Drill holes in stringer to match cross spacing in beam bottom

JOB SHEET #1

G. Coat all forms with form oil

H. If any type of reinforcing is called for, install it on columns and beams

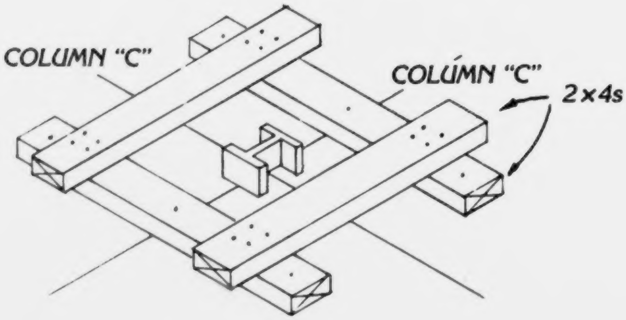
I. Erect column forms

1. Lay out column center lines

2. Nail column template the size of outside of column form to floor with concrete nails or powder-actuated pins (Figure 12)

> **CAUTION**
>
> Do not use powder-actuated tool unless you are certified in its use. Strictly follow all of manufacturer's cautions and instructions before loading or operating the tool.

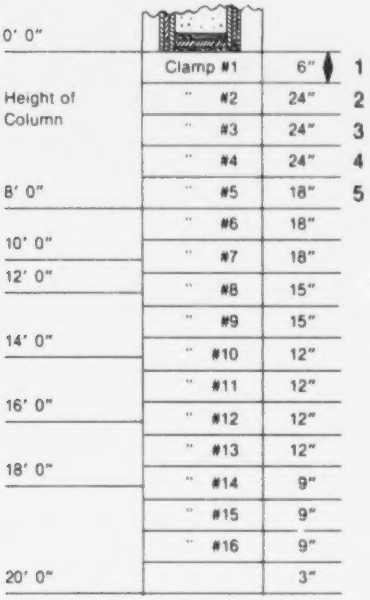
FIGURE 12



3. Use Table 1 to determine column clamp spacing, raising bottom spacing to clear template if necessary

JOB SHEET #1

TABLE 1: Column Clamp Spacing



Height of Column			
0' 0"			
	Clamp #1	6"	1
	" #2	24"	2
	" #3	24"	3
	" #4	24"	4
8' 0"	" #5	18"	5
	" #6	18"	
10' 0"	" #7	18"	
12' 0"	" #8	15"	
	" #9	15"	
14' 0"	" #10	12"	
	" #11	12"	
16' 0"	" #12	12"	
	" #13	12"	
18' 0"	" #14	9"	
	" #15	9"	
	" #16	9"	
20' 0"		3"	

4. Lay out story pole for column clamp spacing
5. Stand opposite column sides in template and nail corner studs with duplex nails
6. Stand the other two sides in template and nail as shown in Figure 13
7. Stand story pole at column corners and mark clamp locations on corner studs
8. Drive 16d nail at each mark (Figures 13 and 14)

   (NOTE: These nails serve to support the clamp during installation. Check type of clamp being used for side location of nails.)

FIGURE 13

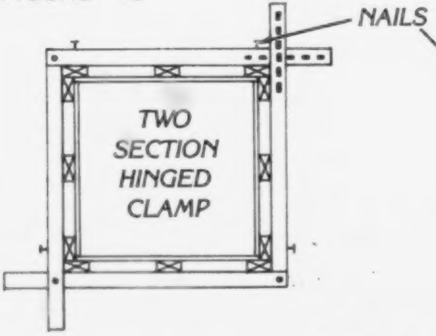
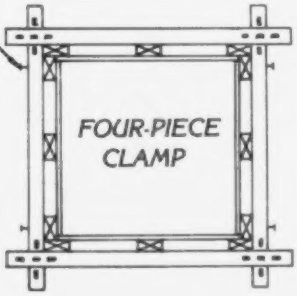


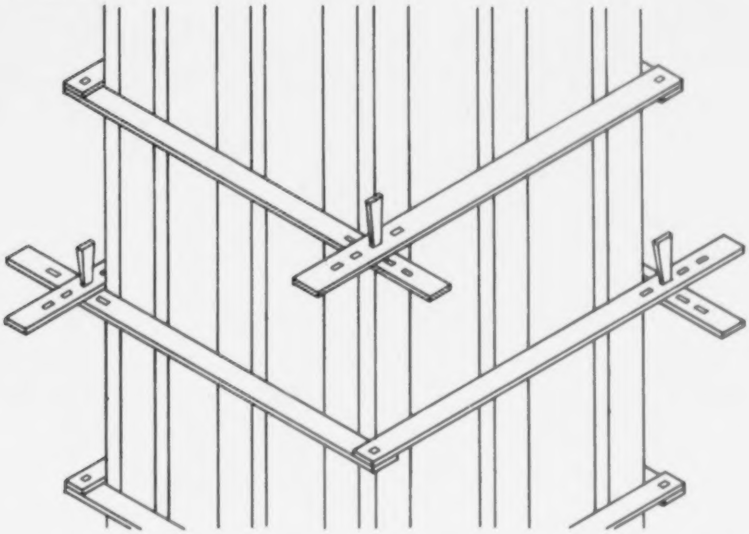
FIGURE 14



JOB SHEET #1

9. Lay column clamps on nails in column form and secure wedges (Figure 14)

FIGURE 14



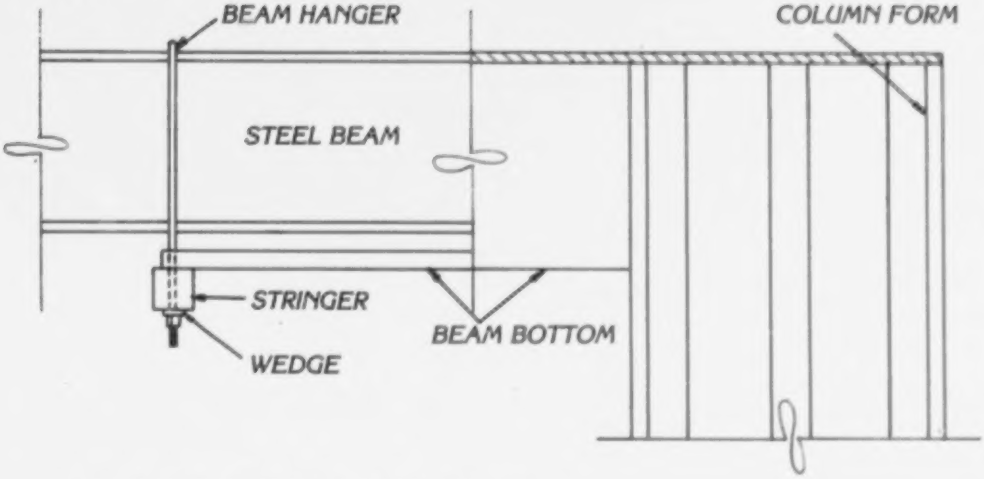
10. Place a wood spacing block between the stud beam and form to hold it plumb

J. Hang beam bottoms

1. Place beam hanger over steel beam close to end of first section of beam bottom
2. Nail a stringer to beam bottom on the end away from column
3. Line up holes for hanger
4. Drive soffit spacers into beam bottom
5. Insert one end of beam bottom into pocket cut out in column side
6. Raise other end and insert beam hanger in predrilled holes
7. Install and secure wedges (Figure 15)

JOB SHEET #1

FIGURE 15

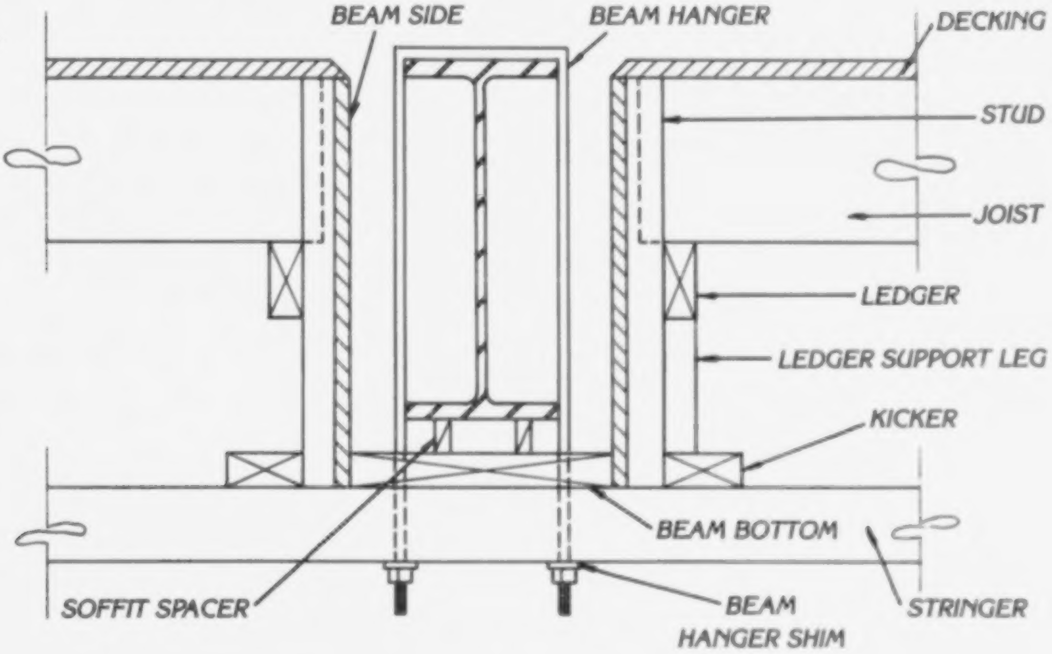

BEAM HANGER
COLUMN FORM
STEEL BEAM
STRINGER
BEAM BOTTOM
WEDGE

8. Install intermediate beam hangers

9. Repeat steps 2 through 8 to continue erection

K. Install beam sides, kicker, and ledger (Figure 16)

FIGURE 16


BEAM SIDE
BEAM HANGER
DECKING
STUD
JOIST
LEDGER
LEDGER SUPPORT LEG
KICKER
BEAM BOTTOM
SOFFIT SPACER
BEAM
HANGER SHIM
STRINGER

JOB SHEET #1

1. Nail beam side to stringer and beam bottom
2. Nail continuous kicker to stringer
3. Nail ledger to studs, locating it so that top of joist is flush with top of beam side
4. Cut ledger support legs to length and nail to studs
5. Align top of beam
    a. Insert spacer between form and flange of beam to establish correct width
    b. Nail a cleat across top of beam sides to hold beam in correct alignment

    (NOTE: The forms are now ready to receive joist and decking for a flat slab.)

L. Clean work area and return tools and materials to proper storage

FIREPROOF ENCASEMENT FORMS
UNIT IX

TEST

NAME ________________________________ SCORE ______________

1. Match to their correct definitions terms associated with fireproof encasement forms. Write correct numbers in the blanks.

______a. Piece of wood or other material that directs, resists, or supports weight or pressure

______b. That part of a beam form that supports vertical pressure

______c. Stud frame and sheathing section that comprise vertical section of beam form

______d. Continuous mass of concrete cast as a single unit

______e. Steel hanger that supports beam and slab forms

______f. Nut that is part of beam hanger

______g. Horizontal board nailed to a form to support intersecting horizontal members

______h. Piece of material placed across several shores; a horizontal or inclined supporting member

______i. Paraffin oil or other manufactured product applied to form to prevent concrete from adhering to form

______j. Process of encasing structural steel members in concrete

1. Soffit spacer
2. Monolithic pour
3. Fireproof encasement
4. Stringer
5. Beam side
6. Ledger
7. Form oil
8. Beam hanger
9. Beam bottom
10. Brace

2. State the purpose of fireproof encasement.

____

____

3. List types of special hardware used to erect fireproof encasement forms.

a. ____

b. ____

TEST

4. Identify the parts of the fireproof encasement form illustrated below. Write the correct numbers in the blanks.

_____a. Beam side

_____b. Beam hanger

_____c. Decking

_____d. Joist

_____e. Stringer

_____f. Column clamp

_____g. Ledger

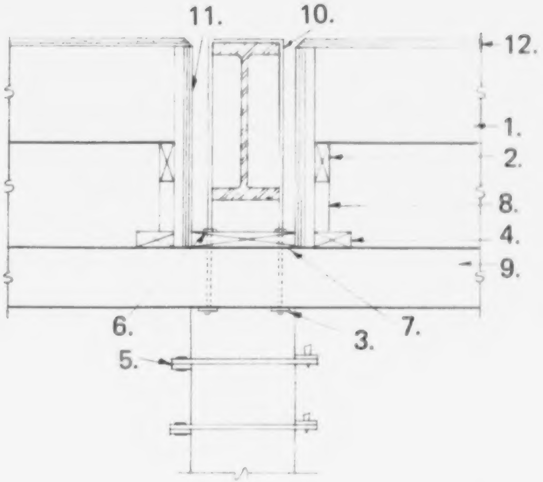
_____h. Ledger support leg

_____i. Kicker

_____j. Beam bottom

_____k. Beam hanger shim

_____l. Soffit spacer



5. List major differences between erection of fireproof encasement forms and erection of structural concrete forms.

a. ______________________________

b. ______________________________

(NOTE: Test question 6 lists the job sheet. It is an important part of this test. If it has not been completed, check with your instructor.)

6. Demonstrate the ability to construct fireproof encasement forms for columns and beams.

FIREPROOF ENCASEMENT FORMS
UNIT IX

ANSWERS TO TEST

1. a. 10
   b. 9
   c. 5
   d. 2
   e. 8
   f. 1
   g. 6
   h. 4
   i. 7
   j. 3

2. To protect structural steel against deterioration caused by overheating

3. a. Beam hangers
   b. Soffit spacers

4. a. 11
   b. 10
   c. 12
   d. 1
   e. 9
   f. 5
   g. 2
   h. 8
   i. 4
   j. 7
   k. 3
   l. 6

5. a. Through ties cannot be used on fireproof encasement forms
   b. Shores do not have to be used to support beam and slab forms for fireproof encasement

6. Performance skills evaluated to the satisfaction of the instructor

STAIR FORMS
UNIT X

UNIT OBJECTIVE

After completing this unit, the student should be able to identify parts and details of stair forms and construct various types of stair forms. The student will show this knowledge by completing the assignment sheet, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with stair forms.
2. Identify parts of a stair form.
3. Name types of concrete stair surfaces.
4. Identify types of stairways.
5. Name types of stair slabs.
6. Identify types of stair forms for each type of slab.
7. State rules for unit rise and unit run.
8. Calculate number and size of stair risers and treads for stairwells of given dimensions.
9. Demonstrate the ability to
    a. Construct forms for a solid set of steps.
    b. Construct forms for earth-supported stairs with open sides.
    c. Construct forms for suspended stairs with open sides.

STAIR FORMS
UNIT X

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency masters

    1. TM #1 — Parts of a Stair Form

    2. TM #2 — Rise and Run of Stairs

  D. Information sheet

  E. Assignment Sheet #1 — Calculate Size and Number of Stair Risers and Treads for Stairwells of Given Dimensions

  F. Answers to assignment sheet

  G. Job sheets

    1. Job Sheet #1 — Construct Forms for a Solid Set of Steps

    2. Job Sheet #2 — Construct Forms for Earth-Supported Stairs with Open Sides

    3. Job Sheet #3 — Construct Forms for Suspended Stairs with Open Sides

  H. Test

  I. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Order or obtain materials needed to supplement unit.

    1. Equipment and materials for job sheet procedures

    2. Framing square and stair gauge for demonstration purposes

    3. Blueprints or plans containing stair plans

    4. Models or mock-ups of various stair forms

SUGGESTED ACTIVITIES

5. Transparencies and competency profiles

   (NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

C. Provide students with unit.

D. Introduce unit.

SUGGESTIONS:

- Explain that the major differences between commercial and residential stair forms are in size and variety. Commercial carpenters are likely to encounter buildings as shopping malls, court houses, businesses, and courtyards or entranceways.

- Explain that forms for larger and wider stairways require more bracing, stringers, and support than those for typical residential construction.

- Discuss unit and specific objectives, explaining how the specific objectives provide the basic knowledge needed to achieve the unit objective.

E. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I, to introduce students to terms associated with stair forms

   SUGGESTIONS:

   - Use Transparencies #1 and #2 to illustrate appropriate terms.

   - Show students samples of materials and examples or pictures of stair forms to illustrate appropriate terms.

2. Use Information Sheet, Section II to introduce students to the parts of a typical stair form.

   SUGGESTIONS:

   - Use Transparency #1 to illustrate your discussion.

   - Tour commercial construction sites and point out the parts of the different stair forms in use.

   - Display models or pictures of stair forms to show the differences among the various types of forms.

SUGGESTED ACTIVITIES

- Use models, if possible, to show how the parts of the forms fit together.

3. Use Information Sheet, Section III to discuss types of concrete stair surfaces.

   SUGGESTIONS:

   - Show students samples of various types of concrete finishes used with monlithic pours and samples of various types of toppings.
   - Take students on a field trip to the community and let them identify the types of finishes and toppings on the stair surfaces they encounter.
   - Explain how different types of toppings may need more depth than others. Point out that some stairs or steps may use toppings on the treads but not on the risers.

4. Use Information Sheet, Section IV to discuss stairway designs.

   SUGGESTIONS:

   - Make a bulletin board of pictures of a variety of stair designs.
   - Have students bring to class pictures of different stair designs. See how many different variations they can find. Use the pictures for a bulletin board display.
   - Take the students on a tour of college, government, or commercial buildings to see how many different stair designs they can discover.

5. Use Information Sheet, Section V and VI to introduce students to types of stair slabs and stair forms for each type of slab.

   SUGGESTIONS:

   - Show students pictures or take students on a tour of the community so that they may see each type of slab.
   - Discuss the reasons for the various types of slabs.
   - Show students examples of the different types of forms for each slab type, pointing out the parts of the forms and explaining how they are used with the different slabs.

6. Use Information Sheet, Sections VII and VIII to discuss rules for unit rise and unit run and how to calculate number and size of stair risers and treads for stairwells of given dimensions.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Use Transparency #2 to illustrate your discussion.
- Demonstrate the use of a framing square and stair gauge in marking stair forms. Allow students to practice using a framing square and stair gauge to mark forms.
- Make sure that students understand that plans of stairs on blueprints or plans seldom show actual dimensions of stairs.
- Use floor plans or create problems to allow students to practice computing riser and tread dimensions.
- Discuss and have students complete Assignment Sheet #1.
- Allow students to construct forms, using Job Sheets #1 through #3. Explain and demonstrate where necessary and emphasize safety and sound building practices.

F. Review unit.

G. Give test.

H. Critique test and discuss in class.

I. Reteach and retest if necessary.

J. Complete appropriate section of compentency profiles.

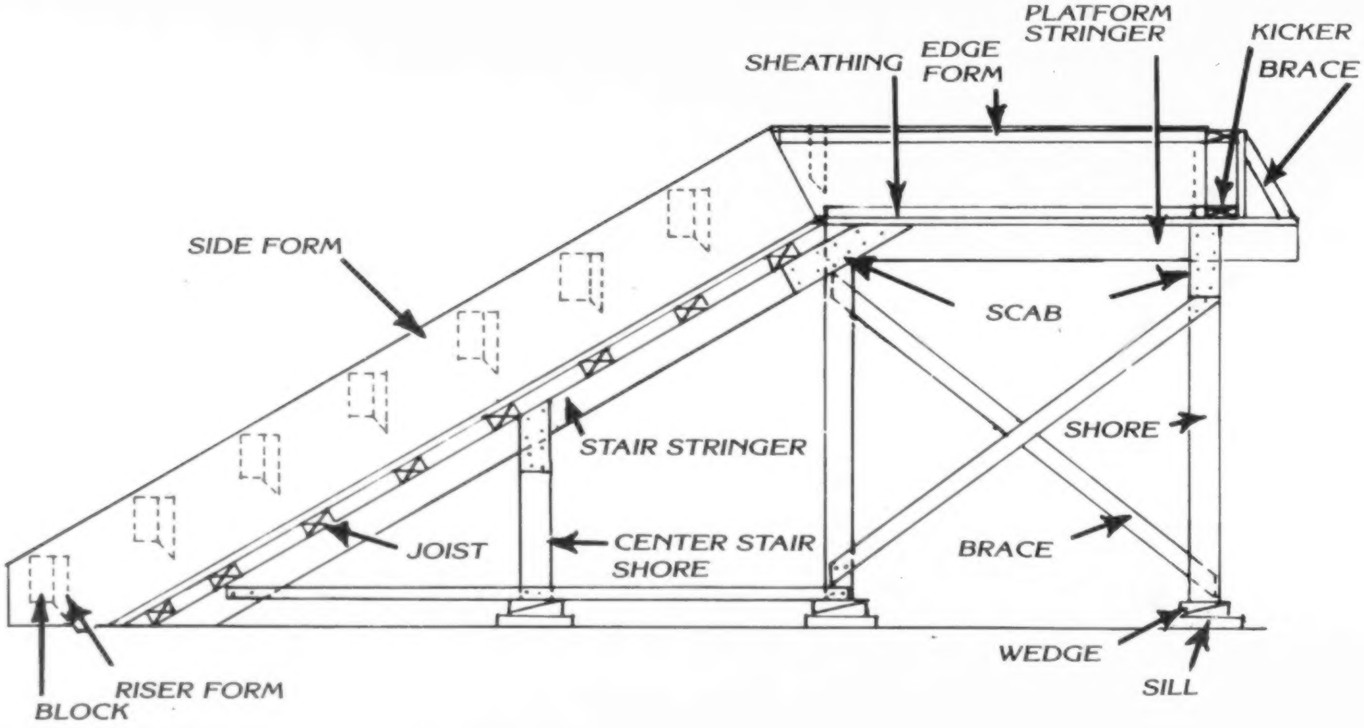
III. Unit references

A. Hendrix, Laborn J. "Bud." *Cement Masonry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1975.

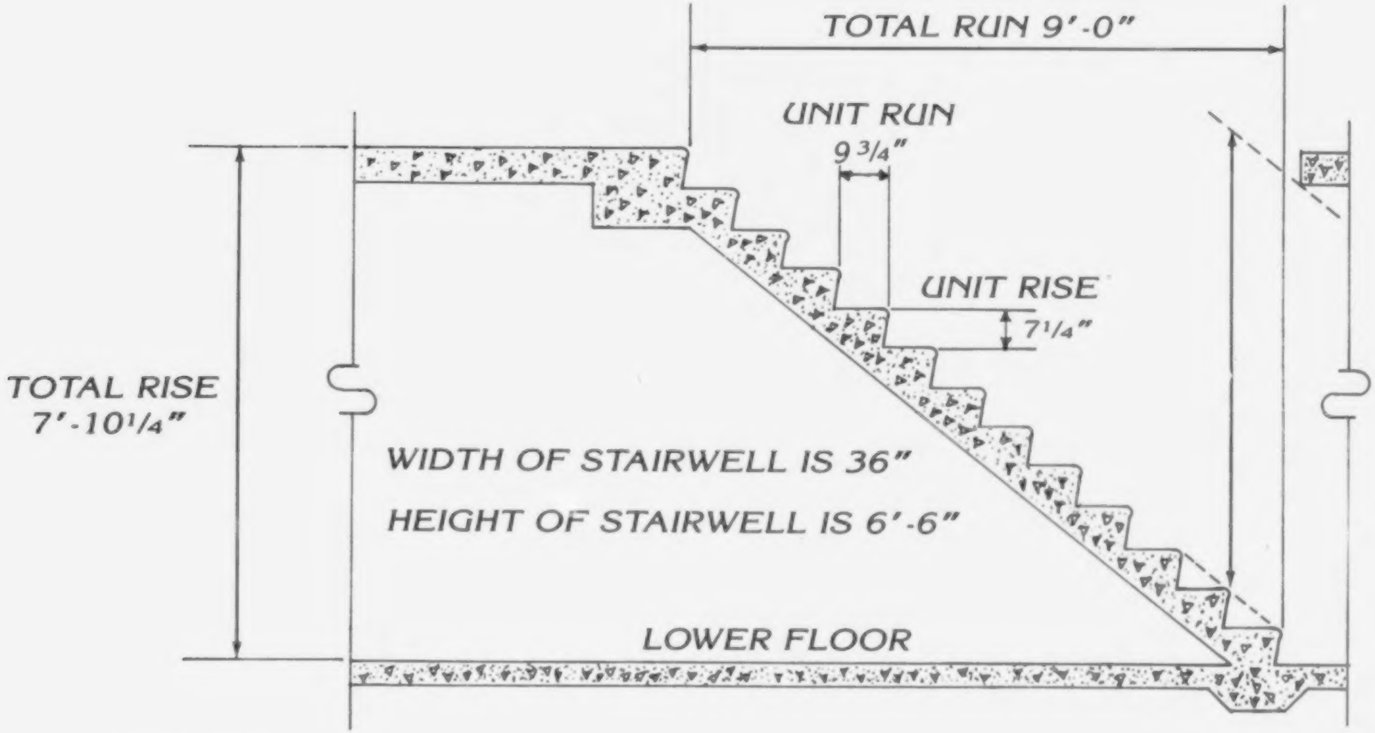
B. Hendrix, Laborn J. "Bud." *Commercial Carpentry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials; Center and The Associated General Contractors of America, 1979.

C. Hendrix, Laborn J. "Bud." *Residential Carpentry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1985.

Parts of a Stair Form


PLATFORM
STRINGER
KICKER
BRACE
SHEATHING
EDGE
FORM
SIDE FORM
SCAB
STAIR STRINGER
SHORE
JOIST
CENTER STAIR
SHORE
BRACE
WEDGE
SILL
RISER FORM
BLOCK

Rise and Run of Stairs


TOTAL RUN 9'-0"
UNIT RUN
9 3/4"
UNIT RISE
7 1/4"
TOTAL RISE
7'-10 1/4"
WIDTH OF STAIRWELL IS 36"
HEIGHT OF STAIRWELL IS 6'-6"
LOWER FLOOR

UNIT RUN = 9" to 11"

UNIT RISE = 7" to 8"

STAIR FORMS
UNIT X

INFORMATION SHEET

I. Terms and definitions

A. Stair stringer (horse) — Inclined supporting member of a stair form or stair

B. Landing — Platform between flights of stairs

C. Stair rise — Distance from floor to top of landing or to floor above

D. Riser — Vertical part of a stair step

E. Stair run — Horizontal distance between first riser and face of platform or stair opening above

F. Tread — Horizontal part of a stair step

G. Pitch board — Wood block used to lay out or support treads and risers

H. Batter — Forward inclination of a riser

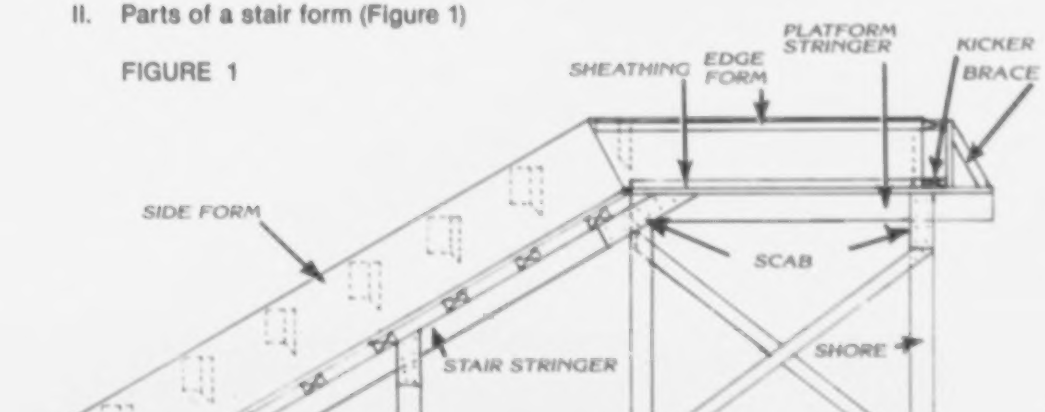
I. Bent — Framework designed to carry lateral as well as vertical loads

J. Stairwell — Compartment extending vertically through a structure and in which stairs are placed

K. Stair gauge — Device attached to framing square to ensure accuracy when laying out material

II. Parts of a stair form (Figure 1)

FIGURE 1


SHEATHING
EDGE FORM
PLATFORM STRINGER
KICKER
BRACE
SIDE FORM
SCAB
STAIR STRINGER
SHORE
JOIST
CENTER STAIR SHORE
BRACE
WEDGE
SILL
RISER FORM
BLOCK

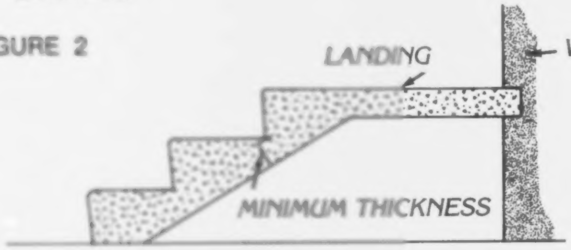
INFORMATION SHEET

III. Types of concrete stair surfaces (Figures 2 and 3)

A. Finished (monolithic pour)

EXAMPLE:

FIGURE 2

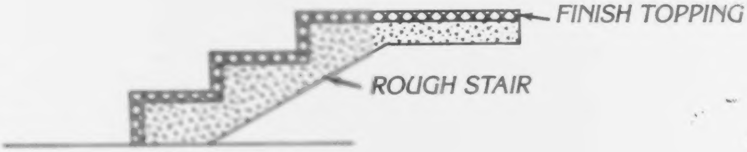

LANDING
WALL
MINIMUM THICKNESS

B. Rough (nonmonolithic pour)

(NOTE: Finish may be terrazzo, concrete, ceramic, tile, stone, or other similar materials.)

EXAMPLE:

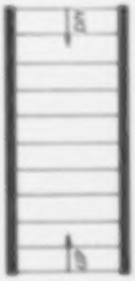
FIGURE 3


FINISH TOPPING
ROUGH STAIR

IV. Types of stairways (Figures 4-12)

A. Straight flight

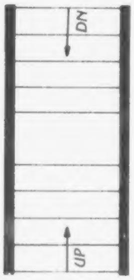
FIGURE 4



INFORMATION SHEET

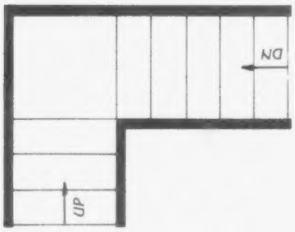
B. Straight flight with landing

FIGURE 5



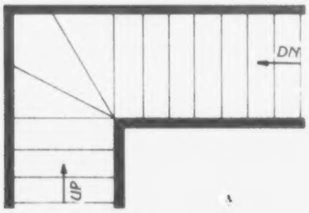
C. 90-degree flights with landing

FIGURE 6



D. 90-degree flights with winders

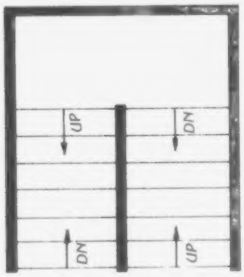
FIGURE 7



INFORMATION SHEET

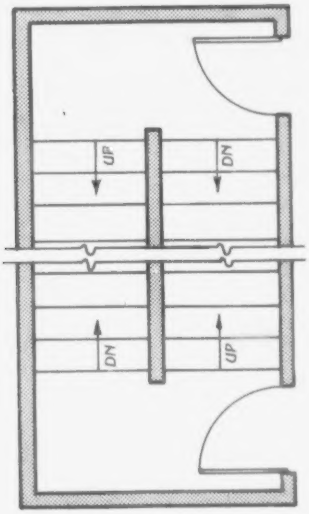
E. U-flights with landing (180-degree)

FIGURE 8



F. Scissor type

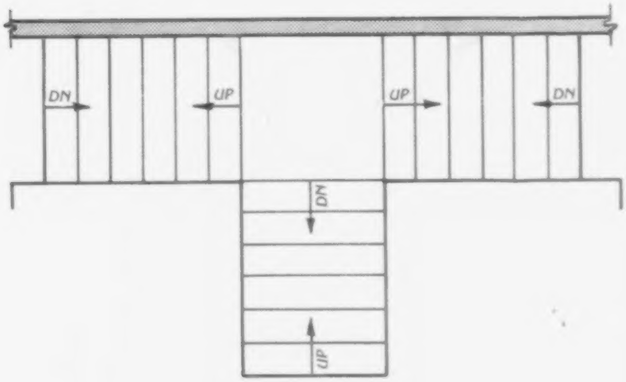
FIGURE 9



INFORMATION SHEET

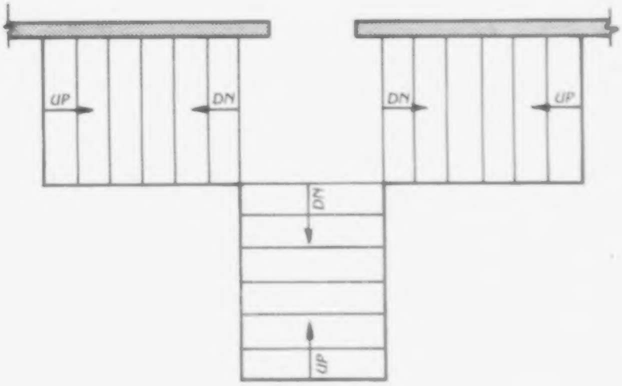
G. "T" or "Y" type with landing

FIGURE 10


DN
UP
UP
DN
DN
UP

H. Pyramid type with landing

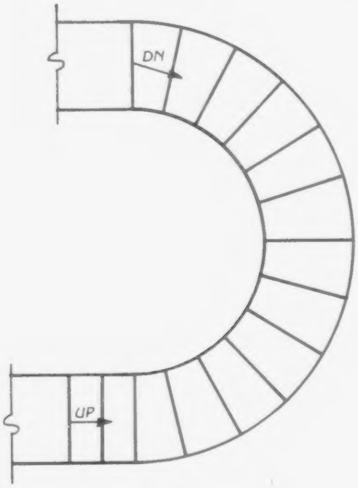
FIGURE 11


UP
DN
DN
UP
DN
UP

INFORMATION SHEET

I. Helicoidal

FIGURE 12

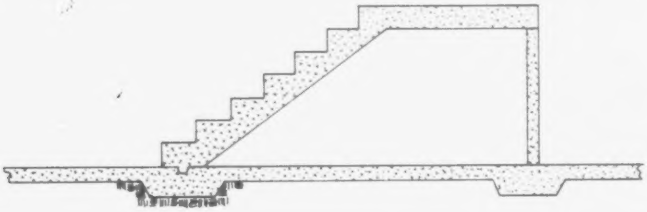


V. Types of stair slabs (Figures 13-16)

A. Suspended

EXAMPLE:

FIGURE 13

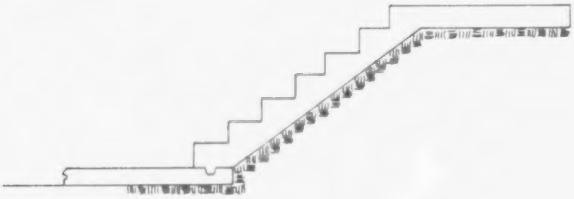


INFORMATION SHEET

B. Earth-supported

EXAMPLE:

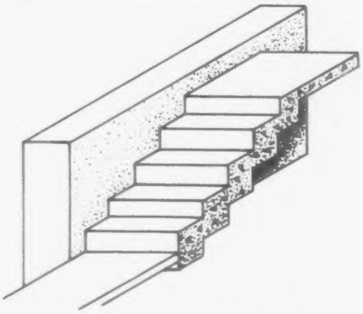
FIGURE 14



C. Cantilever

EXAMPLE:

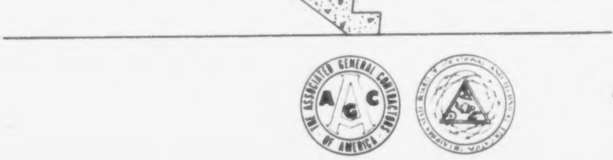
FIGURE 15



D. Free-standing

EXAMPLE:

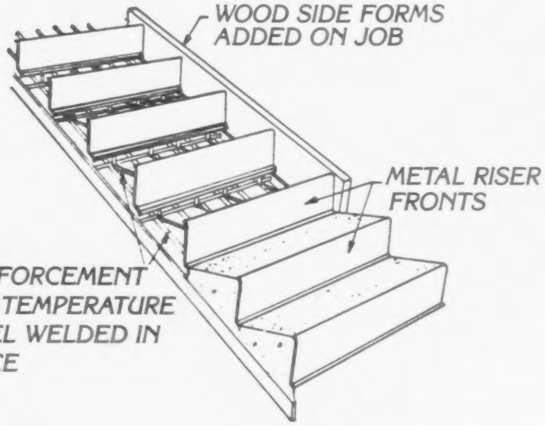
FIGURE 16



INFORMATION SHEET

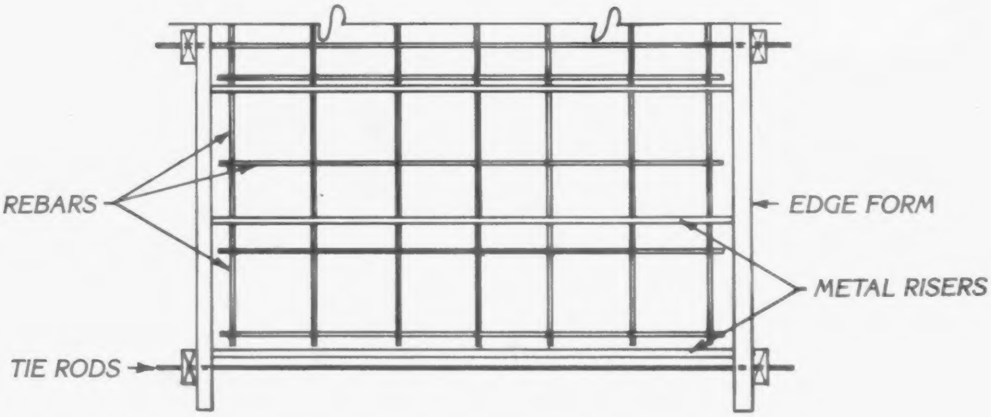
B. Suspended metal forms for stairs open on sides (Figures 19 and 20)

FIGURE 19


WOOD SIDE FORMS ADDED ON JOB
METAL RISER FRONTS
REINFORCEMENT AND TEMPERATURE STEEL WELDED IN PLACE

EXAMPLE: Plan view

FIGURE 20

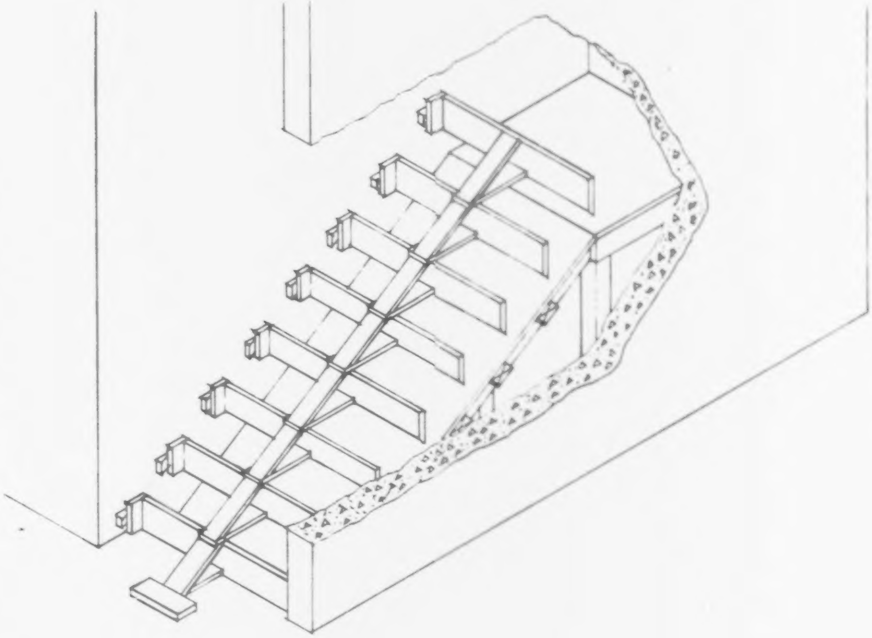

REBARS
EDGE FORM
METAL RISERS
TIE RODS

INFORMATION SHEET

C. Suspended wood forms between walls (Figures 21 and 22)

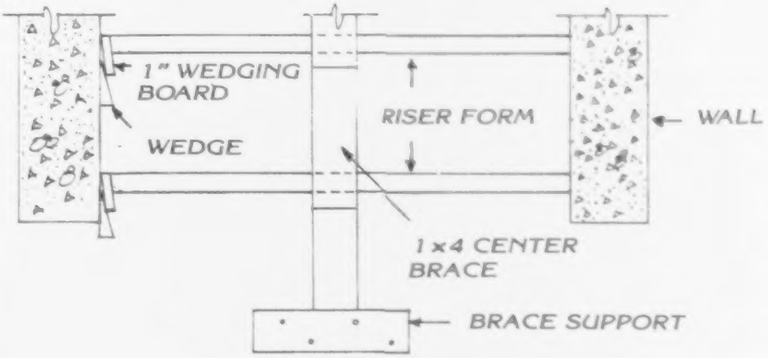
(NOTE: If stairs are 4 feet wide or wider, it is necessary to add a center stringer or center braces as shown in Figure 21.)

FIGURE 21



EXAMPLE: Plan view

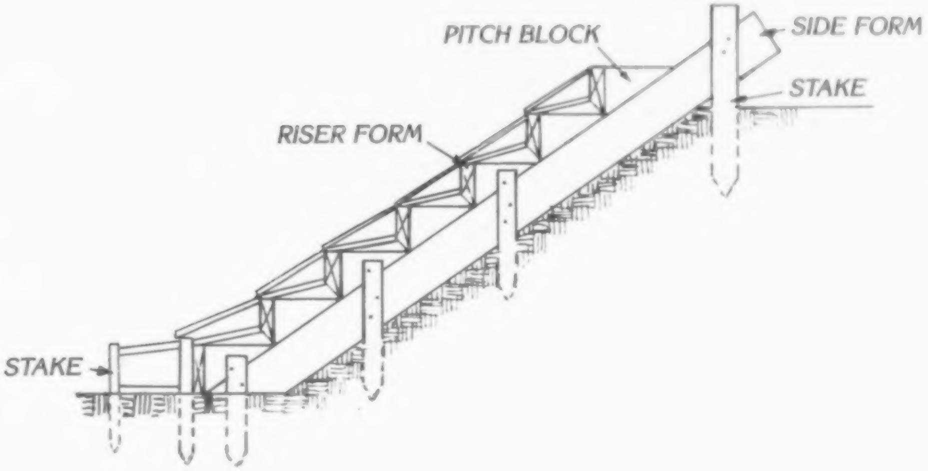
FIGURE 22


1" WEDGING BOARD
WEDGE
RISER FORM
WALL
1×4 CENTER BRACE
BRACE SUPPORT

INFORMATION SHEET

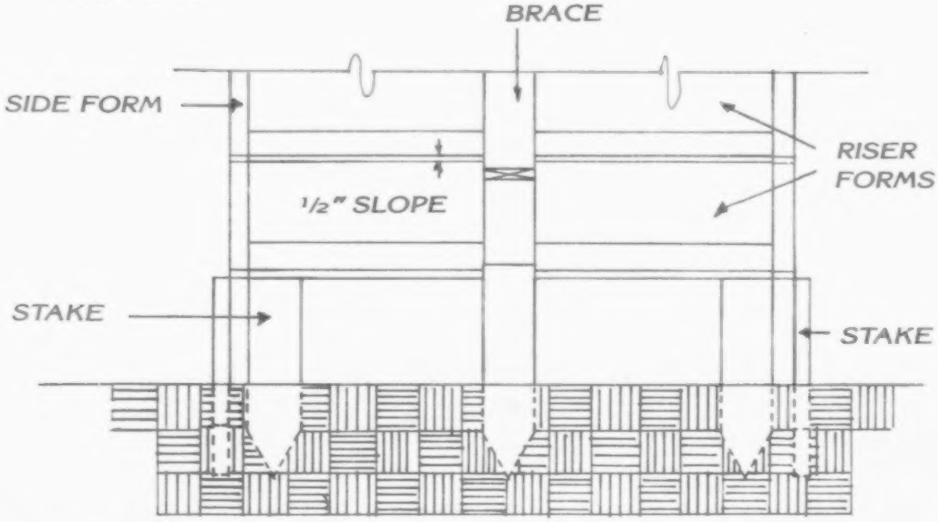
D. Earth-suspended forms, open on sides (Figures 23 and 24)

FIGURE 23


PITCH BLOCK
SIDE FORM
STAKE
RISER FORM
STAKE

EXAMPLE: Elevation view

FIGURE 24

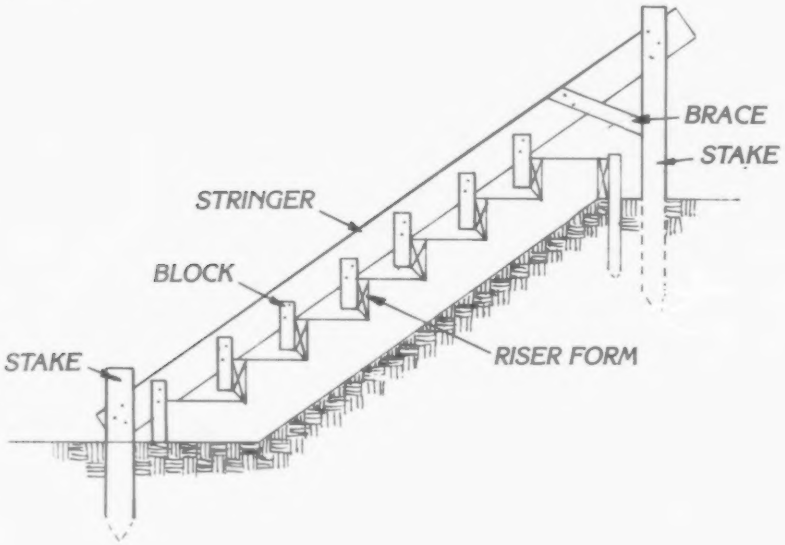

BRACE
SIDE FORM
RISER FORMS
½" SLOPE
STAKE
STAKE

INFORMATION SHEET

E. Earth-supported forms between walls (Figures 25 and 26)

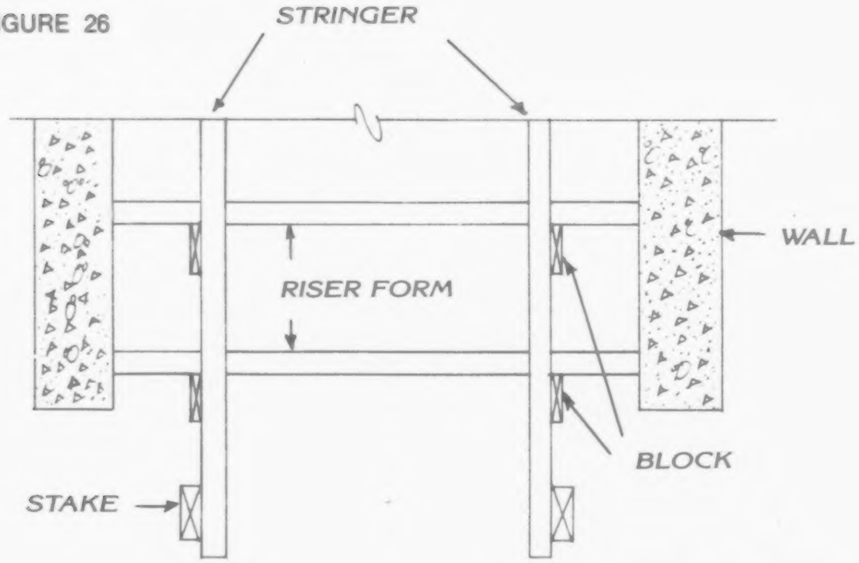
(NOTE: If stairs are 4 feet wide or wider, it is necessary to add a center stringer or center braces.)

FIGURE 25


BRACE
STAKE
STRINGER
BLOCK
RISER FORM
STAKE

EXAMPLE: Plan view

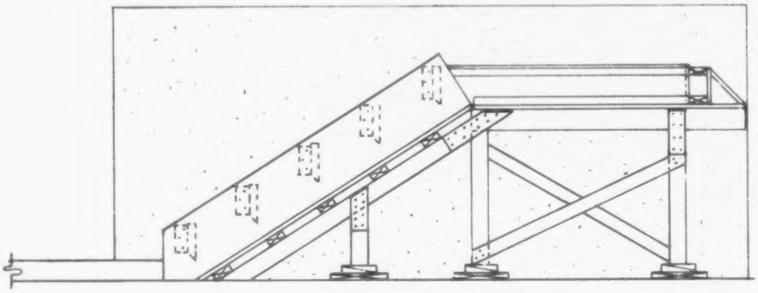
FIGURE 26


STRINGER
WALL
RISER FORM
BLOCK
STAKE

INFORMATION SHEET

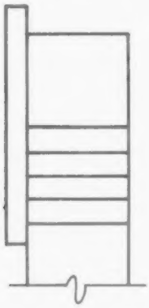
F. Cantilever (Figures 27 and 28)

FIGURE 27



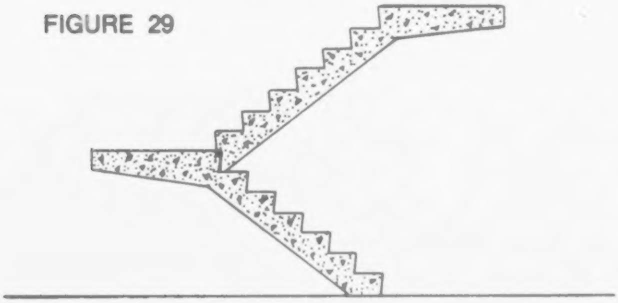
EXAMPLE: Plan view

FIGURE 28



G. Free-standing (Figures 29 and 30)

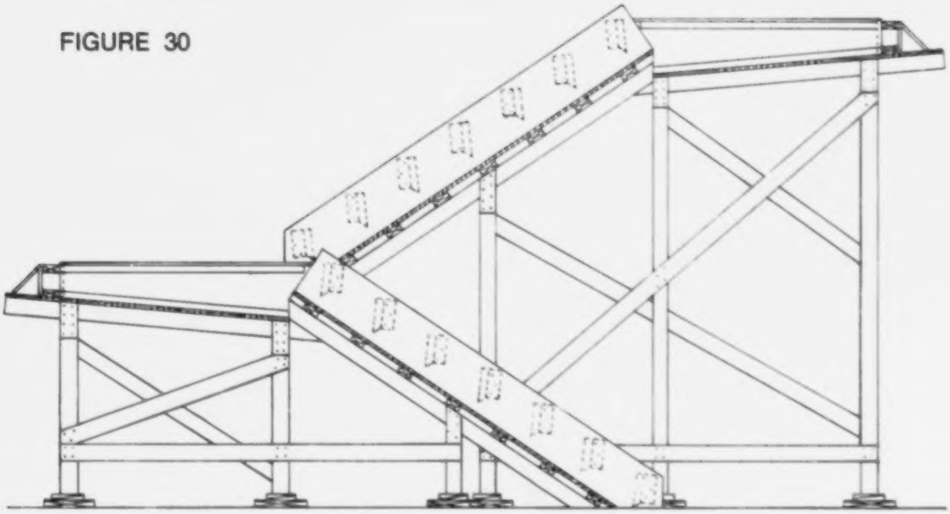
FIGURE 29



INFORMATION SHEET

EXAMPLE:

FIGURE 30



VII. Rules for unit rise and unit run

A. Total of one riser and one tread should not be less than 16 inches or more than 18 inches

B. Unit rise should be 7 inches to 8 inches

C. Unit run should be 9 inches to 11 inches

(NOTE: As the rise increases, the run must decrease proportionally.)

D. Treads and risers must be the same size as other treads and risers for any given set of stairs

VIII. Calculating number and size of risers and treads for stairs

A. Risers

1. Determine total rise of stair in inches

(NOTE: Total rise of a stair is from the finished floor of the lower level to the top of the finished floor of the upper level.)

2. Divide total rise of the stair by 7 to find number of risers needed

(NOTE: Seven inches is the minimum height of a riser.)

3. Round back to nearest whole number

INFORMATION SHEET

EXAMPLE: Total rise is 7′ – 10 1/4″; or 94 1/4 inches.
94 1/4 inches ÷ 7 = 13.46 risers or 13 7/16 risers.
7/16 will not make a full riser, so round back to 13 full risers.

4. Divide total rise by number of risers

EXAMPLE: 94 1/4 inches ÷ 13 = 7 1/4 inches per riser
There would be 13 risers of 7 1/4 inches each.

B. Treads

1. Determine total run of stair in inches

(NOTE: Total run of the stairway is the horizontal distance from a point at the head of the stairs to the outside edge of the last riser.)

2. Determine number of treads by subtracting 1 from the number or risers

(NOTE: There is always one less tread than there are risers.)

3. Divide total run by number of treads

EXAMPLE: Total run is 9′ – 9″ or 117 inches.
117 inches ÷ 12 = 9.75 inches or 9 3/4 inches unit run.
There will be 12 treads of 9 3/4 inches each.

STAIR FORMS
UNIT X

ASSIGNMENT SHEET #1 — CALCULATE SIZE AND NUMBER OF STAIR RISERS AND TREADS FOR STAIRWELLS OF GIVEN DIMENSIONS

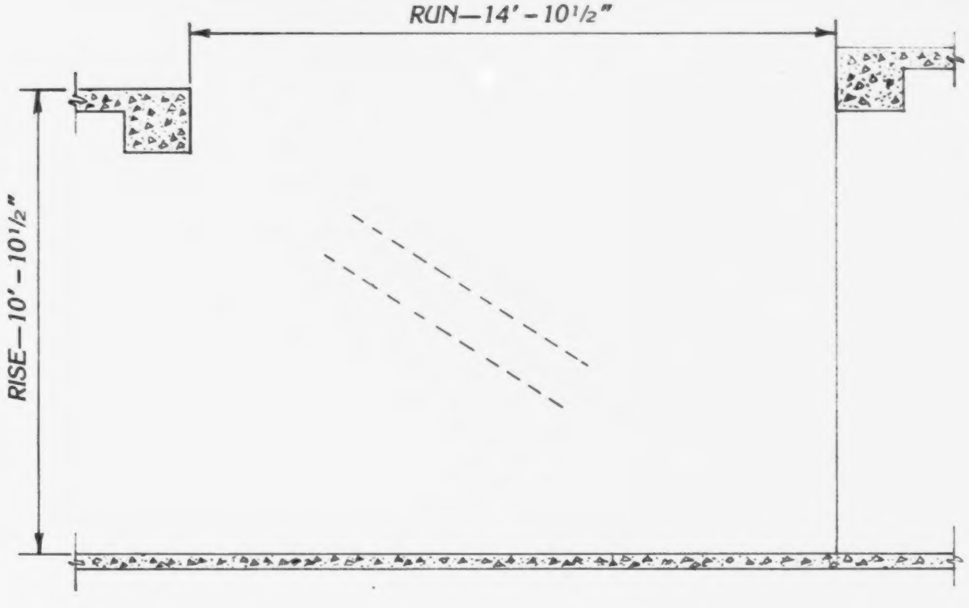
NAME ____________________ SCORE __________

All commercial carpenters should be able to calculate size and number of treads and risers accurately for a specific job. Accurate calculation is cost effective and eliminates mistakes and needless waste of material.

A. Calculate number and size of stair risers and treads for the stairwell illustrated below.

1. Number and size of risers = ____________________

2. Number and size of treads = ____________________

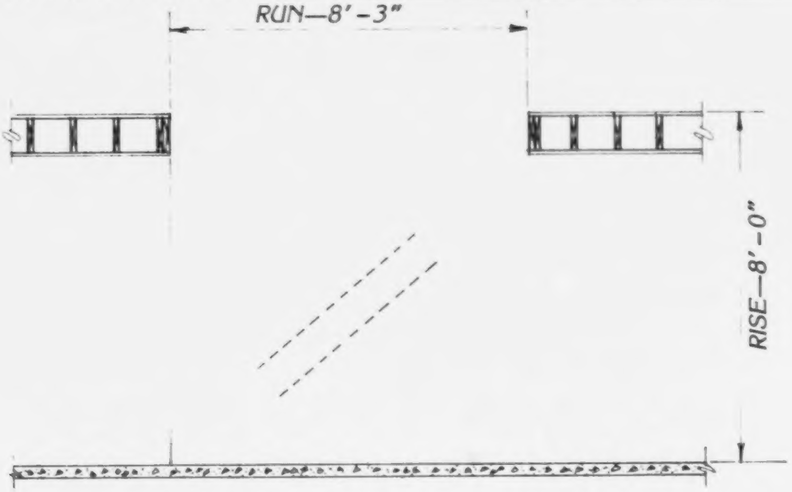


ASSIGNMENT SHEET #1

B. Calculate number and size of stair risers and treads for the stairwell illustrated below.

1. Number and size of risers = ________________________________

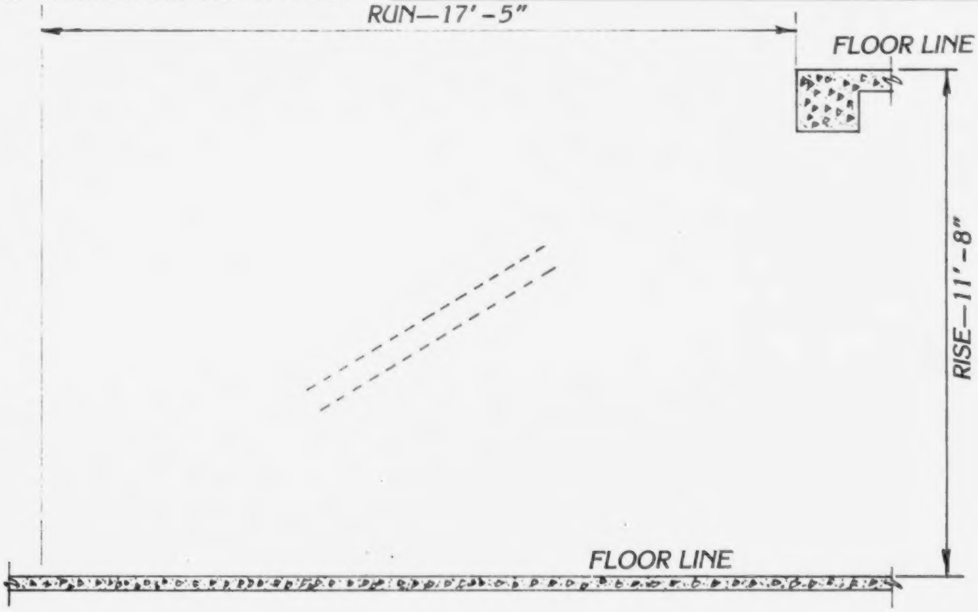
2. Number and size of treads = ________________________________


RUN—8'-3"
RISE—8'-0"

C. Calculate number and size of stair risers and treads for the stairwell illustrated below.

1. Number and size of risers = ________________________________

2. Number and size of treads = ________________________________


RUN—17'-5"
FLOOR LINE
RISE—11'-8"
FLOOR LINE

STAIR FORMS
UNIT X

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A. 1. 18 Risers - 7 ¼"
   2. 17 Treads - 10 ½"

B. 1. 12 Risers - 8"
   2. 11 Treads - 9"

C. 1. 20 Risers - 7"
   2. 19 Treads - 11"

STAIR FORMS
UNIT X

JOB SHEET #1 — CONSTRUCT FORMS FOR A SOLID SET OF STEPS

I. Equipment and materials

  A. Claw hammer

  B. Handsaw

  C. Power handsaw and extension cord

  D. Sledgehammer

  E. Stair gauges

  F. Framing square

  G. Hand level

  H. Electric drill motor and drills

  I. Folding rule or steel tape

  J. Plywood side forms

  K. 2×4s for stakes and stiffner

  L. 2×8s for risers

  M. 1×4s for braces

  N. ½-inch conduit for spreaders

  O. Threaded or smooth rod for ties

  P. 8d and 16d duplex nails

  Q. Protective clothing and eye protection

II. Procedure

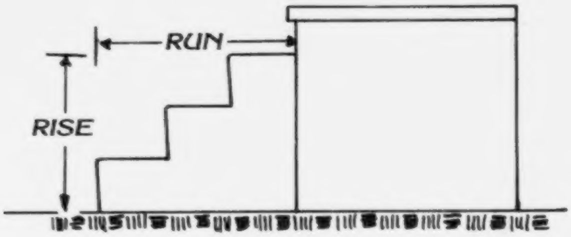
  A. Determine total rise and run

  B. Determine number of risers and number and width of treads

  C. Determine width and length of side form (See Figure 31)

JOB SHEET #1

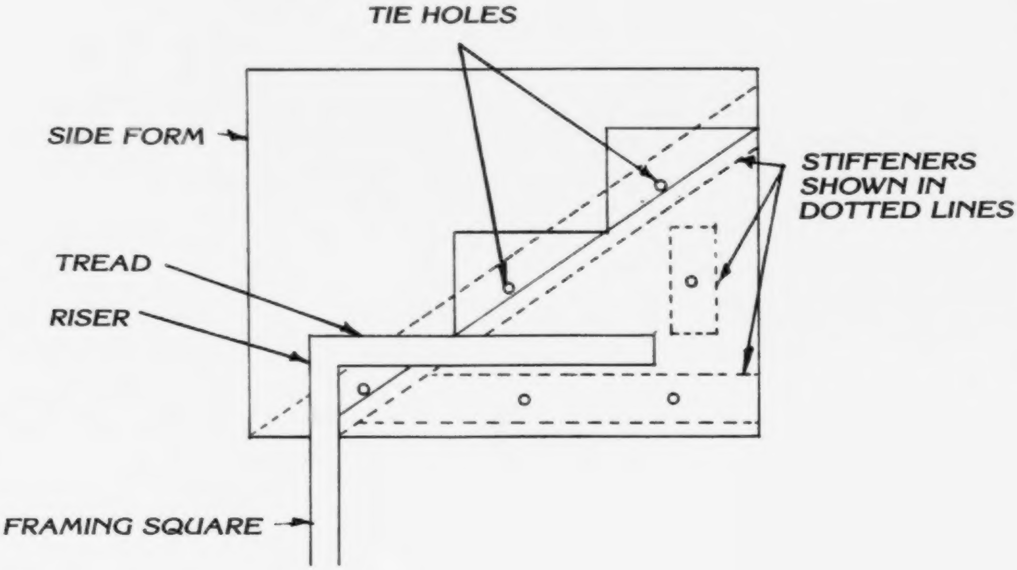
FIGURE 31



D. Cut forms to size

E. Lay out steps on both forms, making a right- and left-hand layout (Figure 32)

FIGURE 32


TIE HOLES
SIDE FORM
STIFFENERS SHOWN IN DOTTED LINES
TREAD
RISER
FRAMING SQUARE

F. Drill tie holes in pattern shown in Figure 32, placing forms back to back, and drilling both sets of holes at the same time

G. Attach stiffeners to back of forms, centering them on tie holes; drill tie holes in stiffners

H. Cut spreaders to length

(NOTE: The spreaders will be as long as the stair is wide.)

JOB SHEET #1

I. Cut threaded rod to length

(NOTE: The rods must be long enough to go through the forms on each side of the stairs with sufficient room for nuts, washers, and a 1-inch projection on each end. See Figure 34)

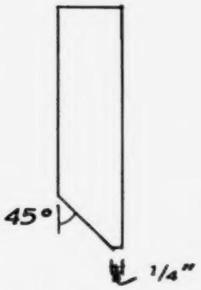
J. Size riser forms

1. Lay out batter of riser on side form to determine exact width
2. Cut riser form to width
3. Cut riser form to length

   (NOTE: Riser form length will be the same as the stair width.)

4. Cut 45-degree angle on bottom edge of tread to facilitate finishing (Figure 33)

FIGURE 33



K. Assemble side forms

1. Stand side forms on level surface
2. Place washer and nut on one end of each rod
3. Insert rods through holes in one form, through spacer, and then through holes in other form; secure with nut and washer at other end
4. Snug up nuts to hold forms together

L. Set assembled form in pour location

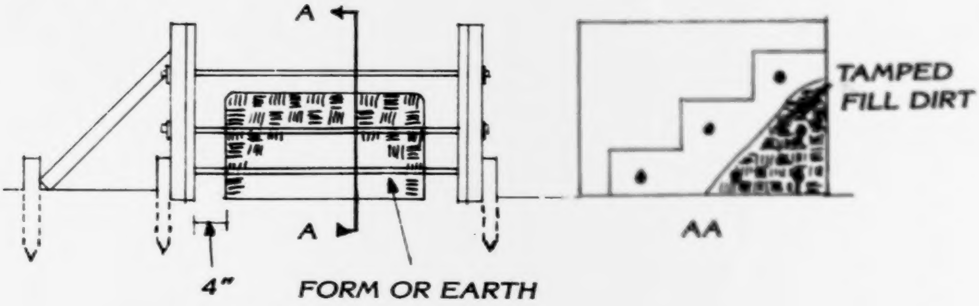
(NOTE: If a form is to be used under the pour, set it in place first.)

JOB SHEET #1

1. Plumb side forms
2. Drive stakes at outside of form sides
3. Raise risers to level position both directions and nail form to stakes

M. Place fill dirt under slab if bottom form is not used (Figure 34)

FIGURE 34



N. Brace as shown in Figure 34

(NOTE: Very little bracing is needed on this type of form.)

O. Check work for accuracy and plumb

P. Clean work area and return equipment and materials to proper storage

STAIR FORMS
UNIT X

JOB SHEET #2 — CONSTRUCT FORMS FOR EARTH-SUPPORTED STAIRS WITH OPEN SIDES

I. Equipment and materials

- A. Claw hammer
- B. Handsaw
- C. Power handsaw and extension cord
- D. Sledgehammer
- E. Stair gauges
- F. Hand level
- G. Builder's level
- H. Framing square
- I. Folding rule or steel tape
- J. Plywood forms
- K. 2×4 stakes
- L. 2×4s for aligners
- M. 2×8s for risers
- N. 2×4s for blocks
- O. 1×4s for braces
- P. 8d and 16d duplex nails
- Q. Protective clothing and eye protection

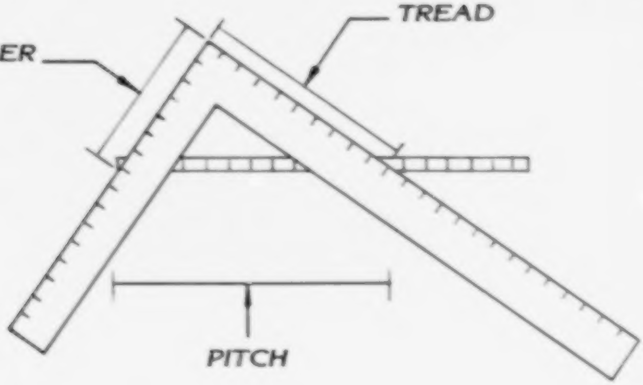
II. Procedure

- A. Determine total rise and run
- B. Determine number of risers and number and width of treads
- C. Determine width and length of side form from rise and run (See Figure 35.)

  (NOTE: Form width will be the slab thickness plus the riser height and 2 inches. Form length will be the length of the pitch of one step times the number of steps in the flight plus 1 foot for overhang.)

JOB SHEET #2

FIGURE 35

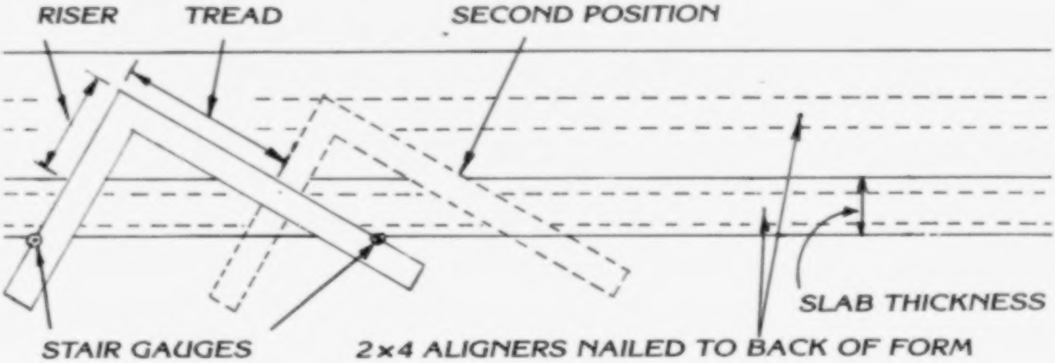

TREAD
RISER
PITCH

D. Cut form sides to size

(NOTE: Form sides may also be made from 1x6 or wider boards cleated together.)

E. Lay out side forms (Figure 36)

FIGURE 36


RISER
TREAD
SECOND POSITION
SLAB THICKNESS
STAIR GAUGES
2x4 ALIGNERS NAILED TO BACK OF FORM

1. Mark a line along bottom length of form equal to slab thickness
2. Lay framing square on form, with riser height and tread width on slab line
3. Attach stair gauges to framing square
4. Mark tread and riser on form

JOB SHEET #2

5. Move square to next step and lay out tread and riser

   (NOTE: Use a sharp pencil, and follow line intersections accurately.)

6. Repeat step 5 to complete layout

7. Lay out opposite side form, following steps 1 to 6

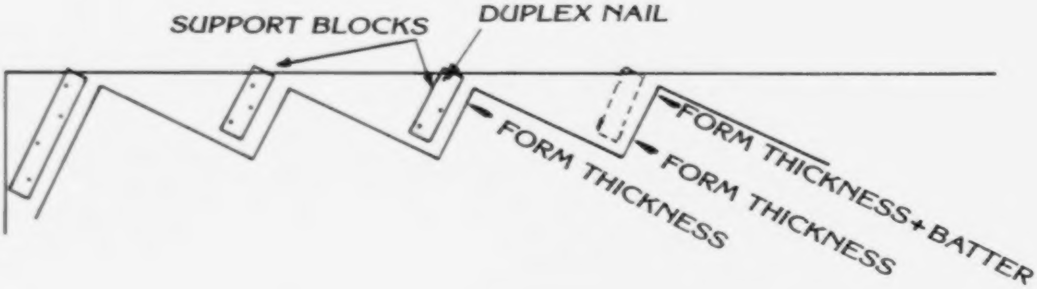
   (NOTE: There will be two form sides. The forms will be laid out for right- and left-hand sides.)

8. Nail aligners to form sides

F. Nail riser support blocks to form sides (Figures 37)

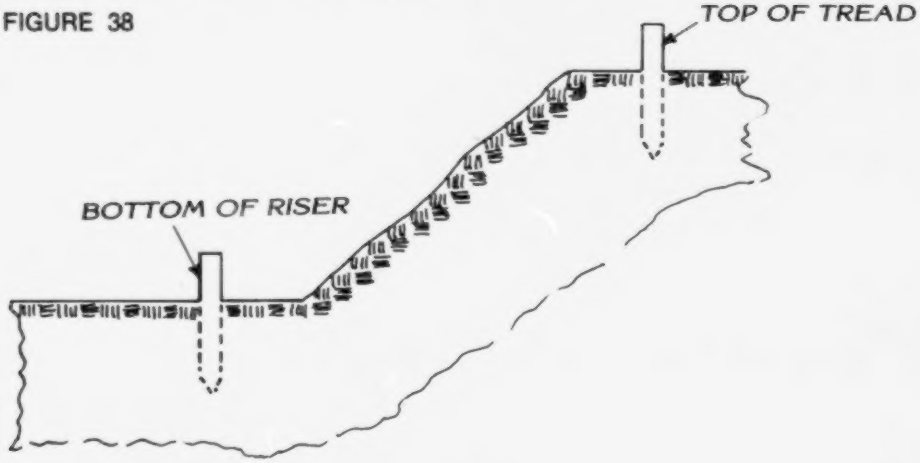
(NOTE: For battered riser, add batter dimension to tread length as shown on right-hand riser in Figure 37.)

FIGURE 37


SUPPORT BLOCKS
DUPLEX NAIL
FORM THICKNESS
FORM THICKNESS
FORM THICKNESS+BATTER

G. Set grade stakes at top and bottom of flight, using builder's level to establish grade from bench mark (Figure 38)

FIGURE 38


TOP OF TREAD
BOTTOM OF RISER

JOB SHEET #2

H. Drive side form support stakes

(NOTE: Remember to allow for sheathing and aligners when driving stakes.)

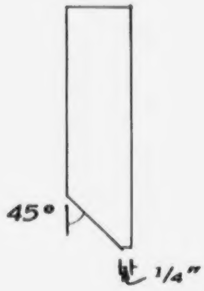
I. Set form sides

1. Set form side against stakes
2. Level over from bottom grade stake to bottom of first riser; adjust form and nail to stake
3. Level over from top stake to top tread line; adjust form and nail to stake
4. Nail form to intermediate stakes
5. Repeat steps 1 to 4 to continue erection

J. Size riser forms

1. Cut form material to length
2. Cut riser forms to width
3. Cut bottom of riser form to 45-degree angle to facilitate finishing (Figure 39)

FIGURE 39



K. Install riser forms

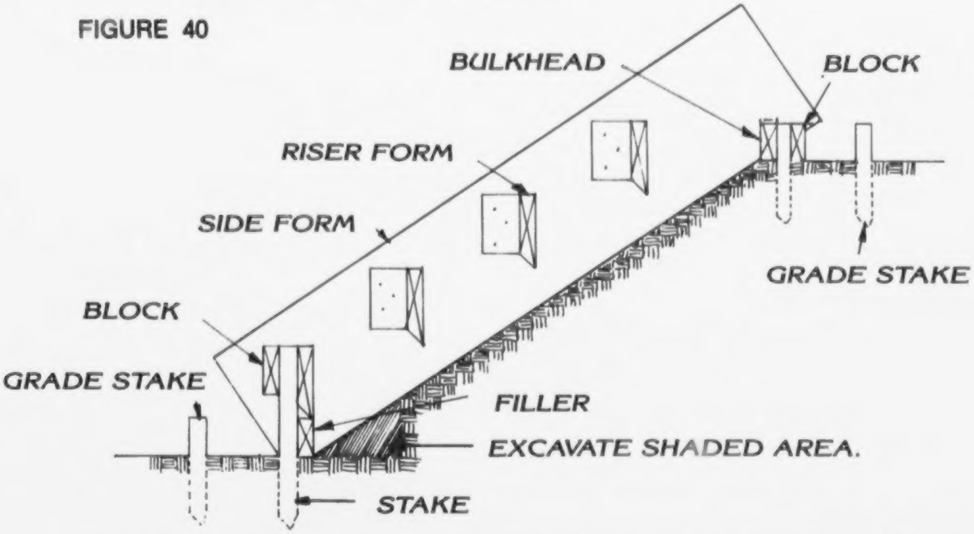
1. Place riser form in position, with top of form flush with tread line and against block
2. Nail riser forms from outside of side form, using duplex nails
3. Repeat steps 1 and 2 to continue installation

   (NOTE: If bottom landing slab is not poured at this time, a filler piece the thickness of the slab will have to be installed under the bottom riser form.)

JOB SHEET #2

L. Install bulkhead at top tread (Figure 40)

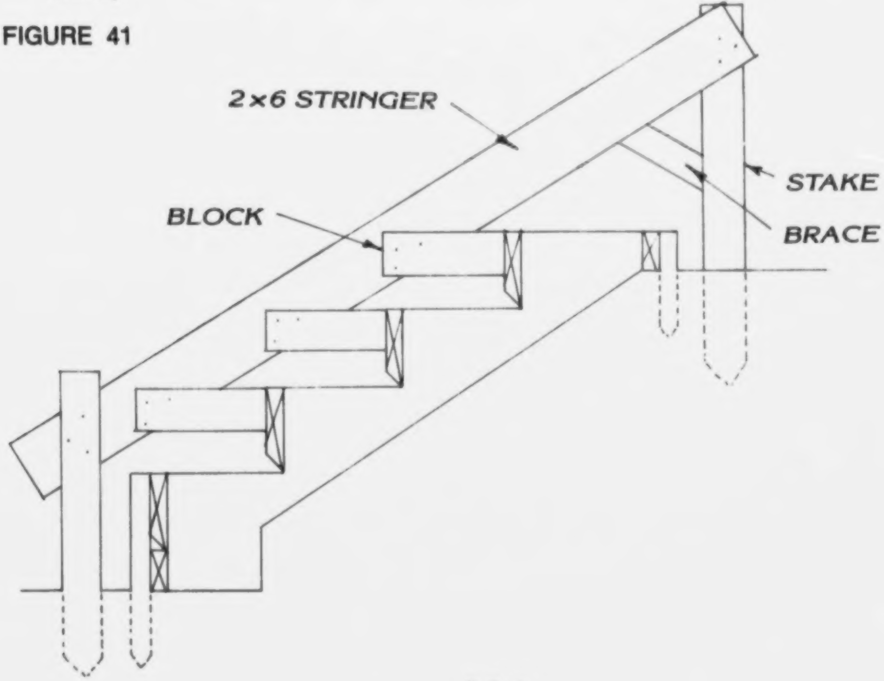
FIGURE 40


BULKHEAD
BLOCK
RISER FORM
SIDE FORM
GRADE STAKE
BLOCK
GRADE STAKE
FILLER
EXCAVATE SHADED AREA.
STAKE

M. Install center support, making sure that stringer is at least 1 inch above the riser to allow for work room (Figure 41)

(NOTE: Center supports are not needed on flights of stairs 4 feet or less in width.)

FIGURE 41


2×6 STRINGER
STAKE
BLOCK
BRACE

JOB SHEET #2

N. Check work for square and plumb

O. Clean work area and return equipment and materials to proper storage

STAIR FORMS
UNIT X

JOB SHEET #3 — CONSTRUCT FORMS FOR SUSPENDED STAIRS WITH OPEN SIDES

I. Equipment and materials

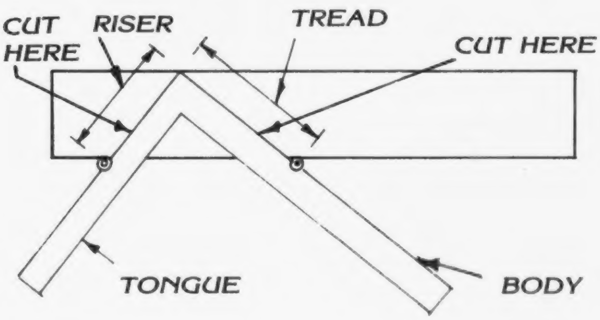
- A. Claw hammer
- B. Handsaw
- C. Power handsaw and extension cord
- D. Hand level
- E. Builder's level and rod
- F. Framing square
- G. Folding rule or steel tape
- H. Framing square stair gauges
- I. Plywood for side forms and decking
- J. 2×4s for stakes, aligners, and blocks
- K. 1×4s for braces
- L. 4×4s for shores, horses, joist, and stringers
- M. 1 ½"×4"×10" for wedges
- N. 2×8s for risers
- O. Protective clothing

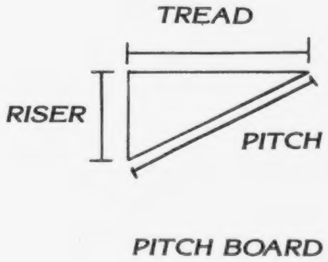
II. Procedure

- A. Make a pitch board (See Figure 42)
  - 1. Attach stair gauges to square to correspond to rise and run of a stair unit
  - 2. Place square on a thin board; mark and cut as shown in Figure 42

JOB SHEET #3

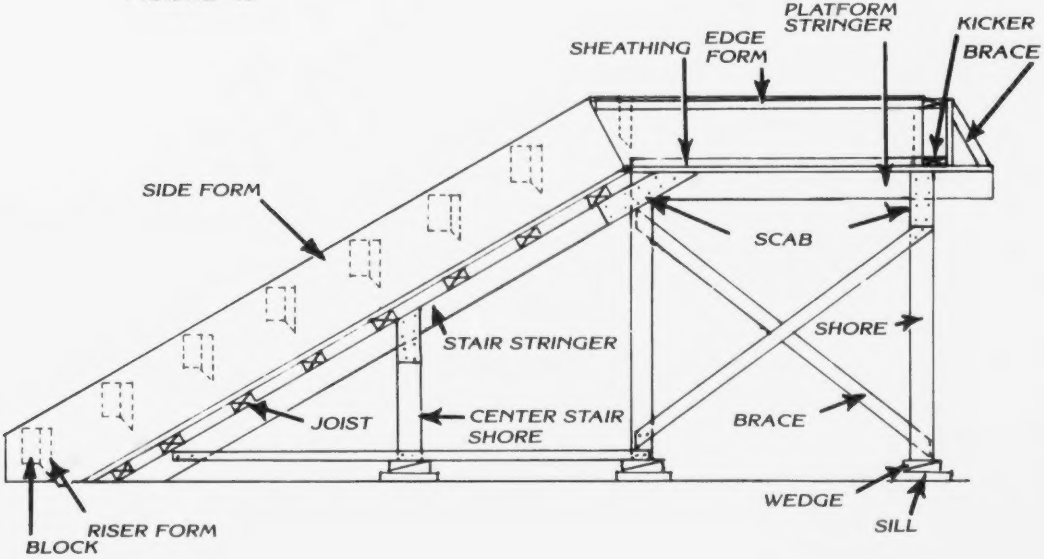
FIGURE 42


CUT HERE
RISER
TREAD
CUT HERE
TONGUE
BODY


TREAD
RISER
PITCH
PITCH BOARD

B. Cut form pieces to size (Figure 43)

FIGURE 43


SHEATHING
EDGE FORM
PLATFORM STRINGER
KICKER
BRACE
SIDE FORM
SCAB
SHORE
STAIR STRINGER
JOIST
CENTER STAIR SHORE
BRACE
WEDGE
SILL
RISER FORM
BLOCK

1. Obtain shore length by subtracting decking, stringer, sill, and wedge thicknesses from bottom of slab height
2. Project stringers past platform a distance equal to height of edge form
3. Cut side forms to width

JOB SHEET #3

  a. Use the pitch board as guide

  b. Measure the step and slab thickness on a line 90 degrees to the pitch

  c. Add 2 inches to determine width at intersection of tread and riser

4. Frame side forms

   a. Measure length of pitch on pitch board

   b. Multiply by number treads

   c. Add 1 foot to determine length

5. Cut joist to length by determining width of slab plus height of two side forms

6. Cut edge forms the same width as slab thickness

7. Cut stringer scabs by laying pitch board on material with pitch side flush with bottom; cut on tread side

8. Cut stringer blocks by laying pitch board on edge of material with pitch side flush with bottom; cut on riser side

9. Size riser forms

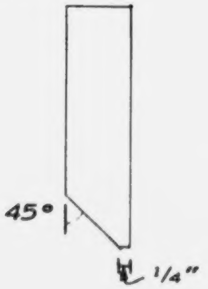
   a. Cut to riser height

   b. Cut to stair width

   c. Cut 45-degree bevel on bottom edge (Figure 44)

   (NOTE: When pouring a rough stair, it is not necessary to cut the bottom of the riser form at a 45-degree angle.)

FIGURE 44

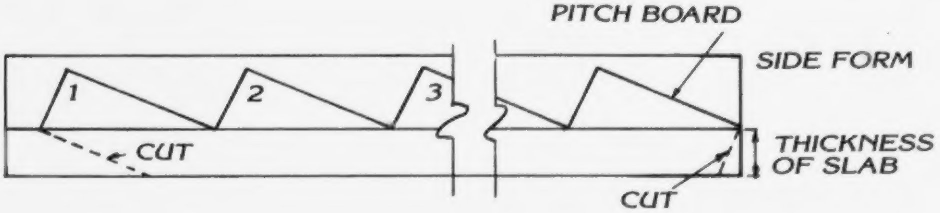


JOB SHEET #3

C. Lay out side forms (See Figure 45)

(NOTE: Two side forms are needed, one right-hand and one left-hand.)

FIGURE 45


PITCH BOARD
SIDE FORM
1
2
3
CUT
THICKNESS OF SLAB
CUT

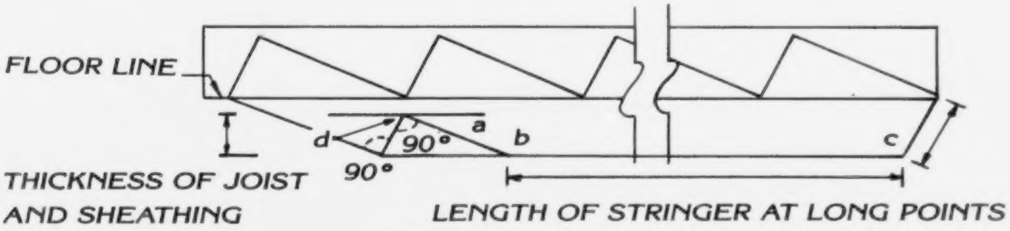
1. Scribe a pencil line on the form equal to thickness of slab
2. Lay pitch side of pitch board on line and mark tread and riser position #1 as illustrated in Figure 45 allowing for thickness of riser form
3. Move pitch board to position #2 and mark tread and riser
4. Repeat step 3 to lay out step #3 and all other steps in the flight

   (NOTE: Intersect all lines accurately. Use a sharp pencil.)

5. Lay out and cut ears as shown by dotted lines in Figure 45

D. Lay out and cut stringers (Figure 46)

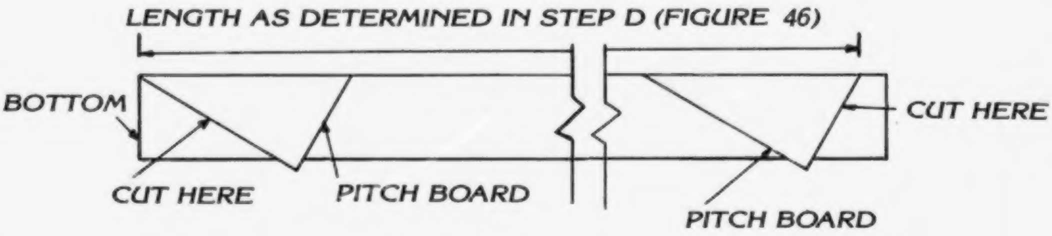
FIGURE 46


FLOOR LINE
a
d
90°
b
c
90°
THICKNESS OF JOIST AND SHEATHING
LENGTH OF STRINGER AT LONG POINTS

JOB SHEET #3

1. Scribe a line equal to thickness of joist and sheathing, establishing line a
2. Square from intersection of floor line and bottom of side form to intersect with line a
3. Square from this line to make point b intersect with bottom edge of form
4. Measure from point b to point c to determine length of stringer
5. Lay out this length (the long points) on stringer
6. Lay out top and bottom cuts (Figure 47)

FIGURE 47


LENGTH AS DETERMINED IN STEP D (FIGURE 46)
BOTTOM
CUT HERE
PITCH BOARD
CUT HERE
PITCH BOARD

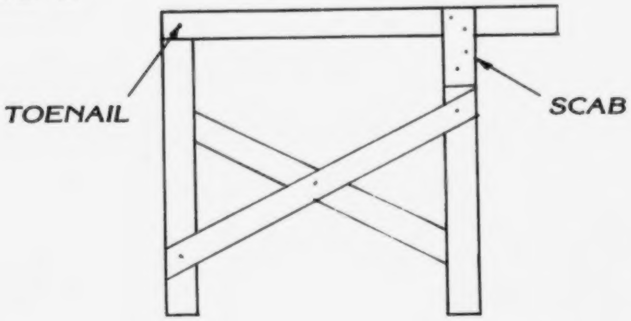
7. Cut on lines as shown in Figure 47

E. Erect shores and stringers

1. Nail two shores to each stringer and cross brace as shown in Figure 48

   (NOTE: Place a block the thickness of the shore between braces to nail crossing point.)

FIGURE 48


TOENAIL
SCAB

   2. Lay sills on floor at location of shores

   3. Tack wedges to sill at shore locations

   4. Stand end shores upright; tack spacer board across top; cross brace

   5. Install crossmembers between shores

F. Install stringers

   1. Measure length of line d in Figure 46 from top to decking to determine location of stringer

   2. Tack top of the stringer to shore at this location

   3. Nail cleat across stringers and shore

   4. Repeat steps 1 and 2 to complete erection

G. Nail joist to stringers, spacing as needed to allow a uniform overhang on each side

H. Nail decking to joist and stringers, using a minimum of nails to hold decking in place

I. Lay out sides of stair and landing, dropping a plumb bob from the edge of stair hole to establish lines

J. Install side forms and edge forms

(NOTE: Form oil must be applied before rebars are installed.)

   1. Nail a continuous kicker to deck, placing kicker the thickness of riser forms back from layout lines

   2. Stand forms upright on deck, and nail to kicker

K. Install riser form

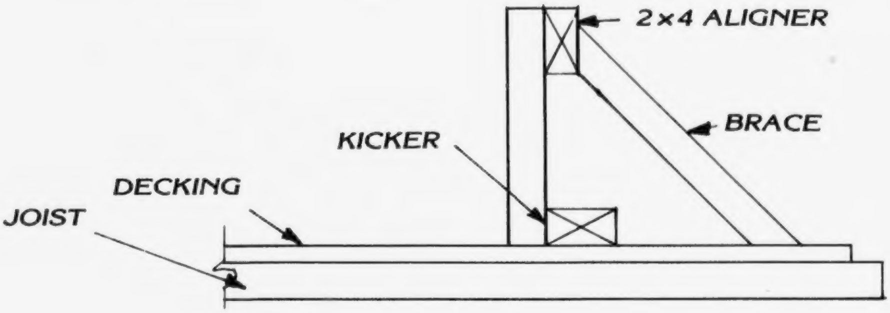
   1. Hold riser form on riser layout line

   2. Nail through form side with duplex nails

JOB SHEET #3

L. Install aligner, and brace side forms (Figure 49)

FIGURE 49


2×4 ALIGNER
BRACE
KICKER
DECKING
JOIST

M. Install blocks at risers

(NOTE: Blocks are not needed if the tread form material is thick, solid lumber.)

N. Check work for square and plumb

O. Clean up work area and put away tools and materials

CC - 551-A

STAIR FORMS
UNIT X

TEST

NAME ______________________________ SCORE ______________

1. Match to their correct definitions terms associated with stair forms. Write the correct numbers in the blanks.

   ______a. Inclined supporting member of a stair form or stair

   ______b. Platform between flights of stairs

   ______c. Distance from floor to top of landing or to floor above

   ______d. Vertical part of a stair step

   ______e. Horizontal distance between first riser and face of platform or stair opening above

   ______f. Horizontal part of a stair step

   ______g. Wood block used to lay out or support treads and risers

   ______h. Forward inclination of a riser

   ______i. Framework designed to carry lateral as well as vertical loads

   ______j. Compartment extending vertically through a structure and in which stairs are placed

   ______k. Device attached to framing square to ensure accuracy when laying out material

   1. Tread
   2. Stair rise
   3. Riser
   4. Stair stringer (horse)
   5. Landing
   6. Stair run
   7. Stairwell
   8. Batter
   9. Stair gauge
   10. Bent
   11. Pitch board

TEST

2. Identify the parts of the stair form illustrated below. Write the correct numbers in the blanks.

_____a. Stair stringer (horse)

_____b. Joist

_____c. Block

_____d. Riser form

_____e. Side form

_____f. Sheating

_____g. Edge form

_____h. Brace

_____i. Platform stringer

_____j. Shore

_____k. Wedge

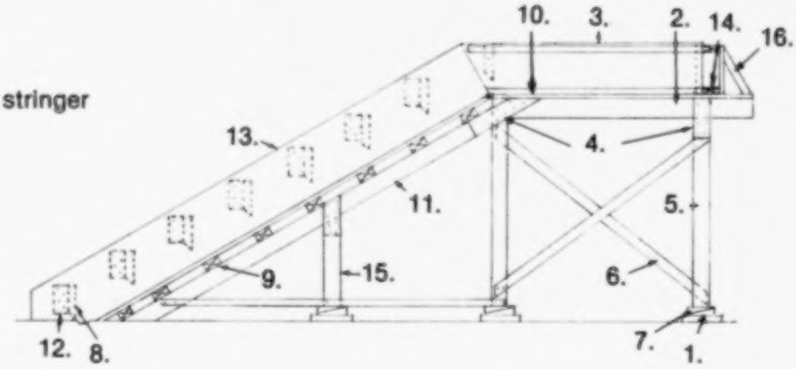
_____l. Sill

_____m. Scab

_____n. Kicker

_____o. Center support

_____p. Brace



3. Name types of concrete stair surfaces.

a. ____

b. ____

TEST

4. Identify the following types of stairways. Write the correct numbers in the blanks.

______a. Straight flight

______b. Straight flight with landing

______c. 90-degree flights with landing

______d. 90-degree flights with winders

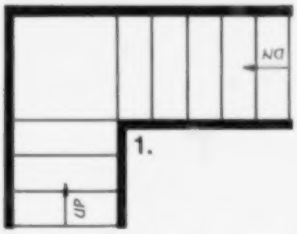
______e. U-flights with landing (180-degrees)

______f. Scissor type

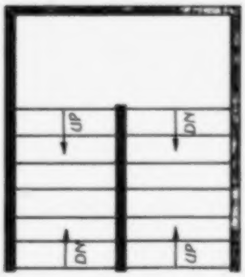
______g. "T" or "Y" type with landing

______h. Helicoidal

______i. Pyramid type with landing

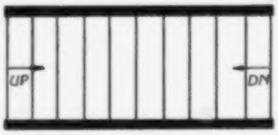


1.

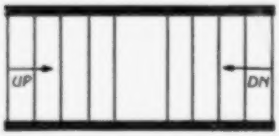


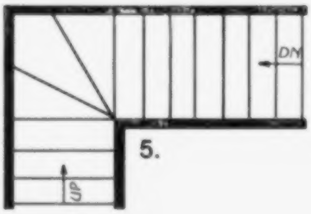
2.

3.



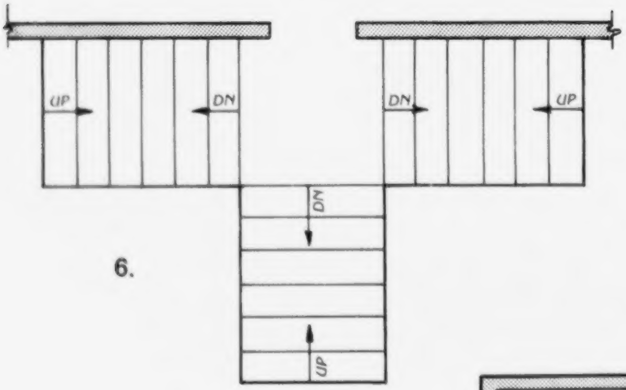
4.



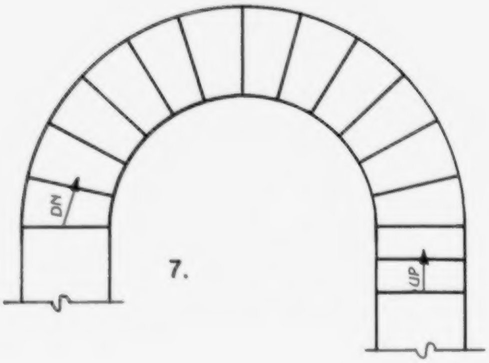


5.

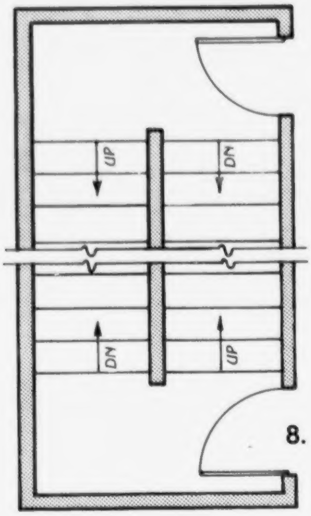
TEST


UP
DN
DN
UP
DN
UP

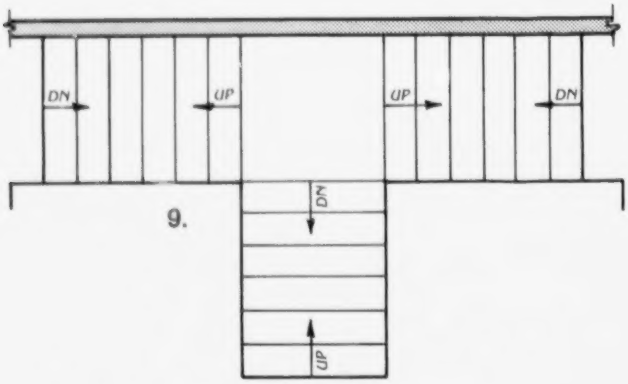
6.



7.



8.


DN
UP
UP
DN
DN
UP

9.

TEST

5. Name three types of stair slabs.

a. ______________________________

b. ______________________________

c. ______________________________

6. Identify the following types of stair forms. Write the correct names in the blanks.

Suspended wood forms for stairs open on sides

Suspended metal forms for stairs open on sides

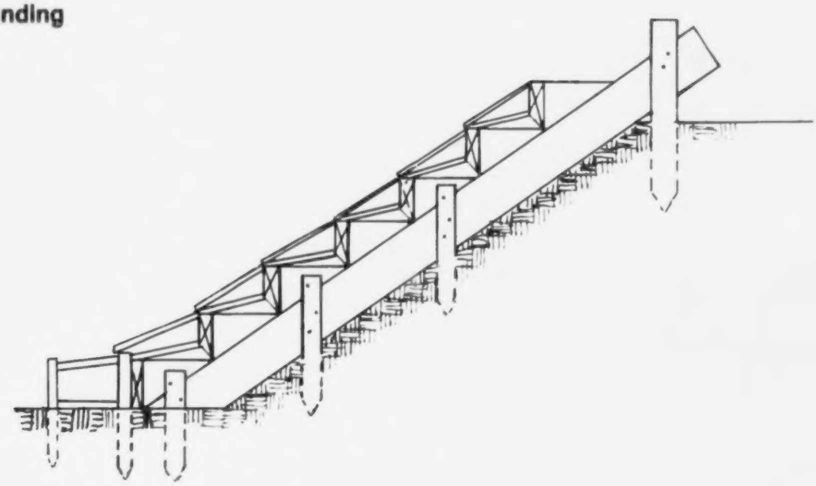
Suspended forms between walls

Earth-supported forms for stairs open on slides

Earth-supported forms between walls

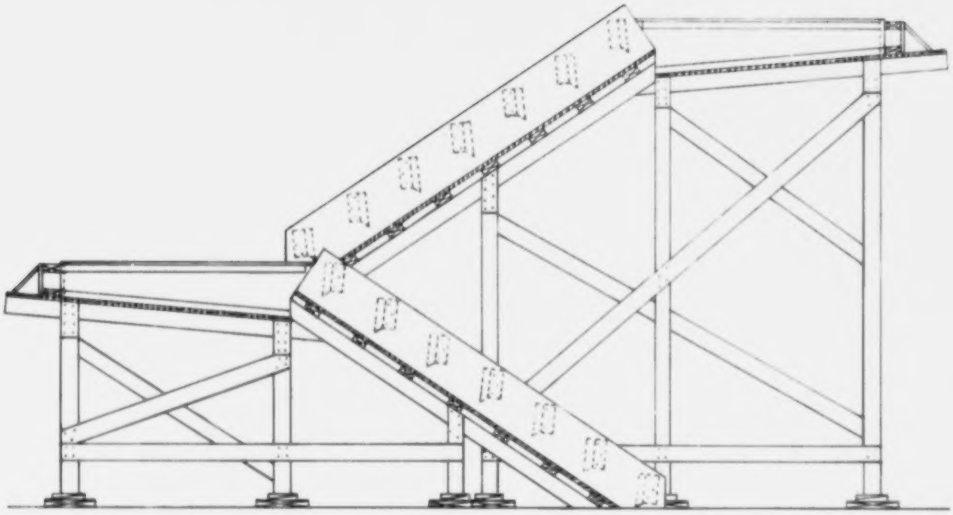
Cantilever

Free-standing

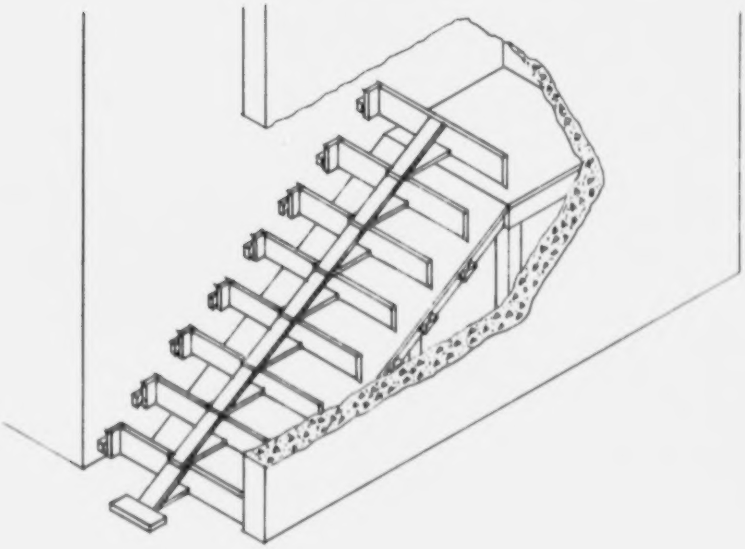


a. ______________________________

TEST

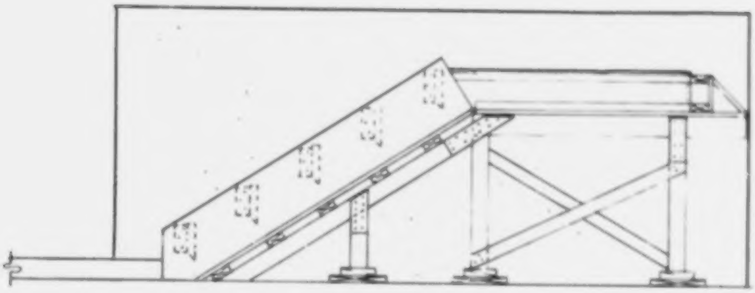


b. ________________________________

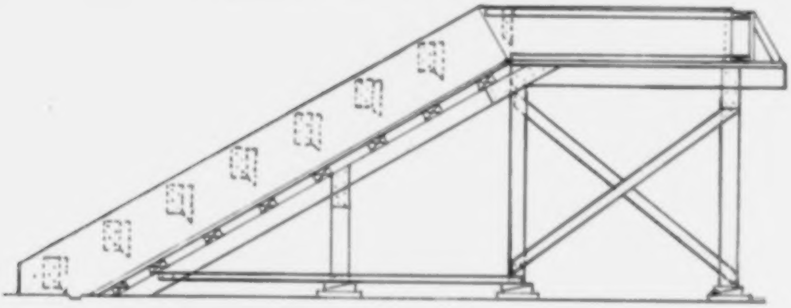


c. ________________________________

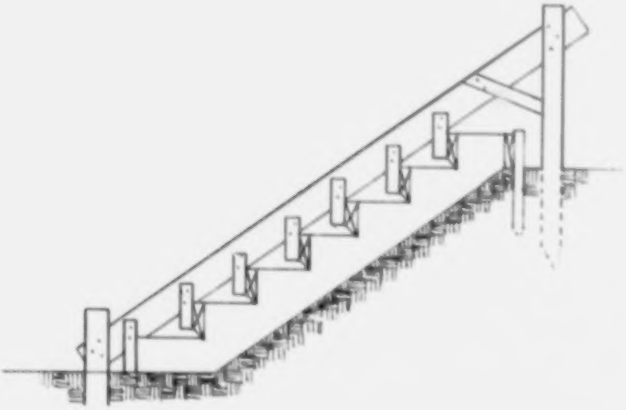
TEST



d. ______________________________

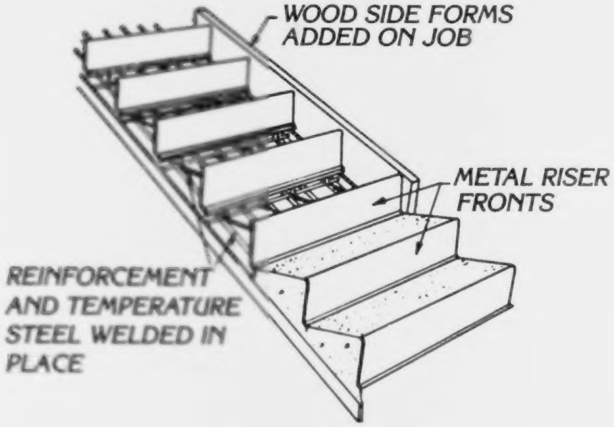


e. ______________________________



f. ______________________________

TEST



WOOD SIDE FORMS ADDED ON JOB
METAL RISER FRONTS
REINFORCEMENT AND TEMPERATURE STEEL WELDED IN PLACE

g. ______________________________

7. State three rules for unit rise and unit run.

a. ____

____

b. ____

____

c. ____

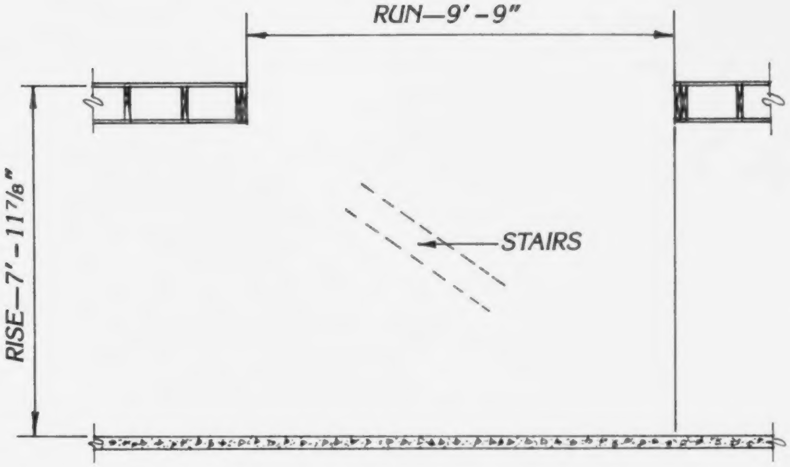
____

TEST

8. Calculate the number and size of risers and treads for the stair illustrated below.

   a. Risers ____________ number ____________ size

   b. Treads ____________ number ____________ size



(NOTE: Test question 9 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

9. Demonstrate the ability to

   a. Construct forms for a solid set of steps.

   b. Construct forms for earth-supported stairs with open sides.

   c. Construct forms for suspended stairs with open sides.

STAIR FORMS
UNIT X

ANSWERS TO TEST

1. a. 4
   b. 5
   c. 2
   d. 3
   e. 6
   f. 1
   g. 11
   h. 8
   i. 10
   j. 7
   k. 9

2. a. 11
   b. 9
   c. 12
   d. 8
   e. 13
   f. 10
   g. 3
   h. 6 or 16
   i. 2
   j. 5
   k. 7
   l. 1
   m. 4
   n. 14
   o. 15
   p. 6 or 16

3. a. Rough (nonmonolithic pour)
   b. Finished (monolithic pour)

4. a. 3
   b. 4
   c. 1
   d. 5
   e. 2
   f. 8
   g. 9
   h. 7
   i. 6

5. Answer should include any three of the following
   a. Suspended
   b. Earth-supported
   c. Cantilever
   d. Free-standing

6. a. Earth-supported form for stairs open on sides
   b. Free-standing
   c. Suspended forms between walls
   d. Cantilever
   e. Suspended wood forms for stairs open on sides
   f. Earth-supported forms between wall
   g. Suspended metal forms for stairs open on sides

ANSWERS TO TEST

7. Answer should include any three of the following
   a. Total of one riser and one tread should not be less than 16 inches or more than 18 inches
   b. Unit rise should be 7 inches to 8 inches
   c. Unit run should be 9 inches to 11 inches
   d. Treads and risers must be the same size as other treads and risers for any given set of stairs

8. a. 13 risers, 7 3/8 inches
   b. 12 treads, 9 3/4 inches

9. Performance skills evaluated to the satisfaction of the insructor.

BRIDGE DECK FORMS
UNIT XI

UNIT OBJECTIVE

After completing this unit, the student should be able to name methods of supporting deck forms and construct forms for a bridge deck. The student will show this knowledge by completing the job sheet and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with bridge deck forms.
2. Identify the parts of a bridge deck form.
3. Name methods of supporting deck forms.
4. Name types of bridges that use reinforced concrete slabs.
5. Demonstrate the ability to construct forms for a bridge deck.

BRIDGE DECK FORMS
UNIT XI

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparencies

    1. TM #1 — Parts of a Bridge Deck Form

    2. TM #2 — Methods of Supporting Deck Forms

    3. TM #3 — Methods of Supporting Deck Forms (Continued)

    4. TM #4 — Types of Bridges That Use Reinforced Concrete Slabs

    5. TM #5 — Types of Bridges That Use Reinforced Concrete Slabs (Continued)

  D. Information sheet

  E. Job Sheet #1 — Construct Forms for a Bridge Deck

  F. Test

  G. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation

  B. Order or obtain materials to supplement unit.

    1. Equipment and materials for job sheet procedures

    2. Transparencies and competency profiles

    (NOTE: Transparencies and competency profiles for this manual are available from the State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

  C. Provide students with unit.

SUGGESTED ACTIVITIES

D. Introduce unit.

SUGGESTIONS:

- Discuss unit and specific objectives.
- Discuss the differences in design and construction of bridge forms as compared to other forms.

E. Discuss information and job sheets.

1. Use Information Sheet, Section I to introduce students to terms and definitions associated with bridge deck forms.
2. Use Information Sheet, Section II to introduce students to the parts of a bridge deck form.

   SUGGESTIONS:

   - Use Transparency #1 to illustrate your discussion.
   - Show students each part on a prebuilt form.
3. Use Information Sheet, Section III to discuss methods of supporting deck forms.

   SUGGESTIONS:

   - Use Transparencies #2 and #3 to illustrate your discussion.
   - Explain reasons for applications of each method.
   - Request catalogs from material suppliers or manufacturers.
4. Use Information Sheet, Section IV to discuss types of bridges that use reinforced concrete slabs.

   SUGGESTIONS:

   - Use Transparencies #4 and #5 to illustrate your discussion.
   - Take the students on a tour of bridges in the community. Have students analyze the types of forms that were used and determine whether the bridge is constructed with a reinforced concrete slab.
   - Make a bulletin board of pictures or photos of different types of bridges and bridge deck forms.

SUGGESTED ACTIVITIES

E. Demonstrate procedure outlined in Job Sheet #1.

F. Have students complete Job Sheet #1.

G. Give test.

H. Critique test and discuss in class.

I. Reteach and retest as necessary.

J. Complete appropriate section of competency profiles.

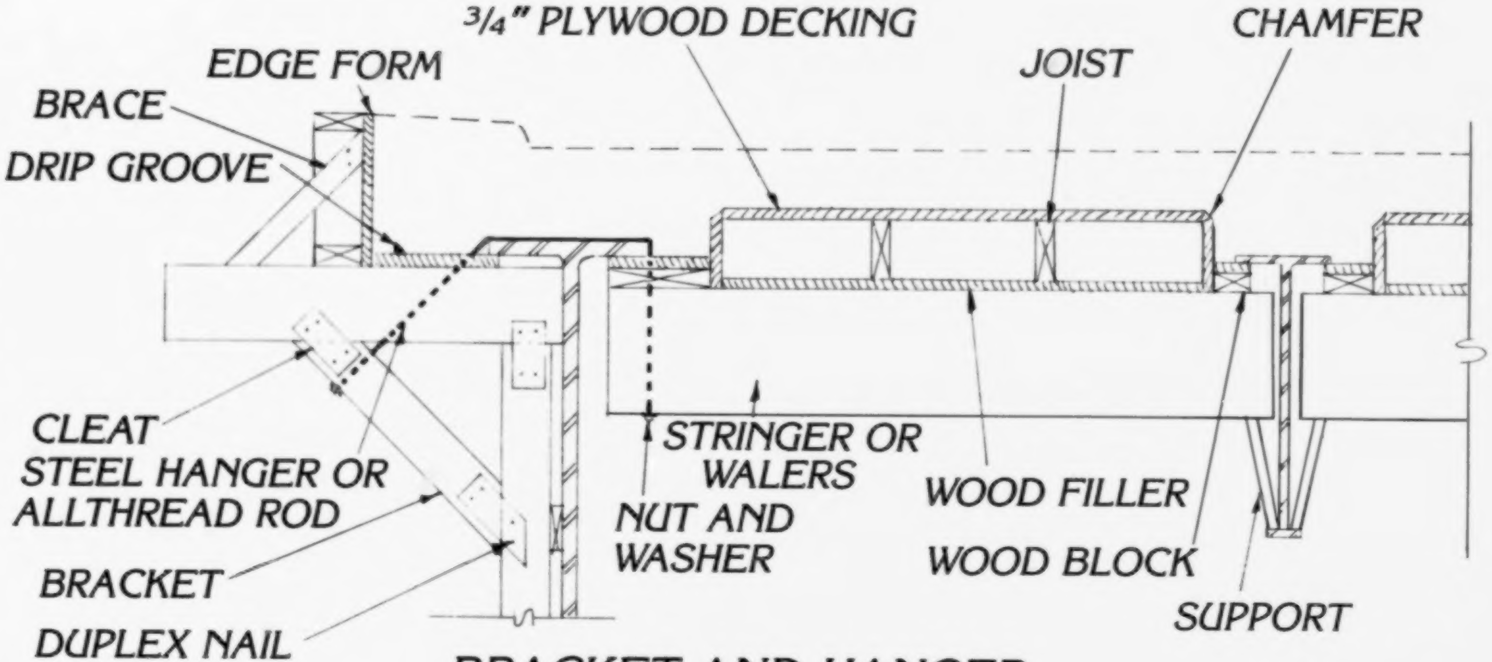
III. Unit references

A. Burke, Arthur E.; Dalzell, J. Ralph; and Townsend, Gilbert. *Architectural and Building Trades Dictionary*. Chicago: American Technical Society, 1955.

B. Smith, Ronald C. *Principles and Practices of Heavy Construction*. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1970.

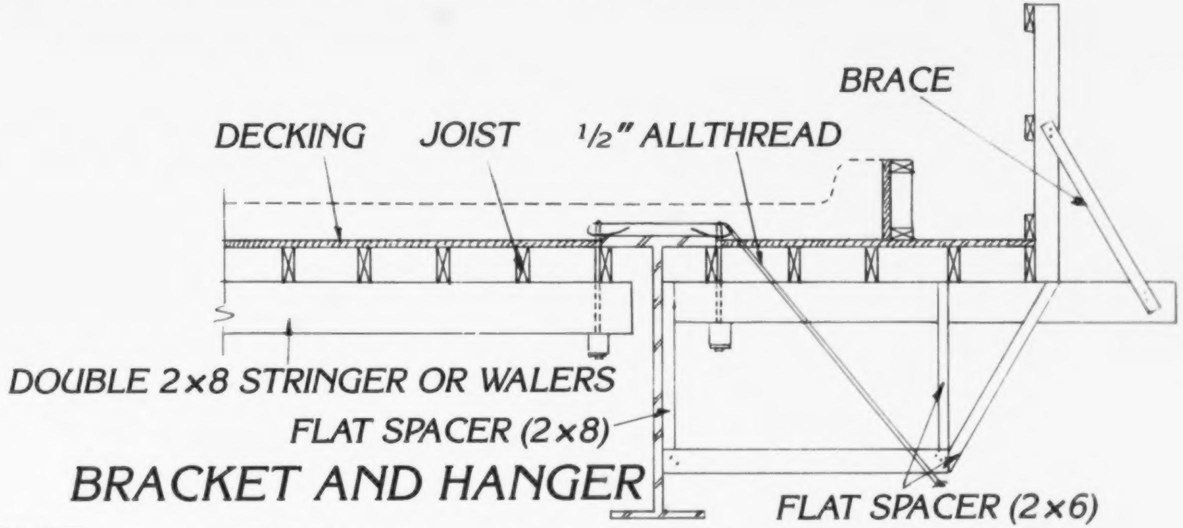
C. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1979.

Parts of a Bridge Deck Form

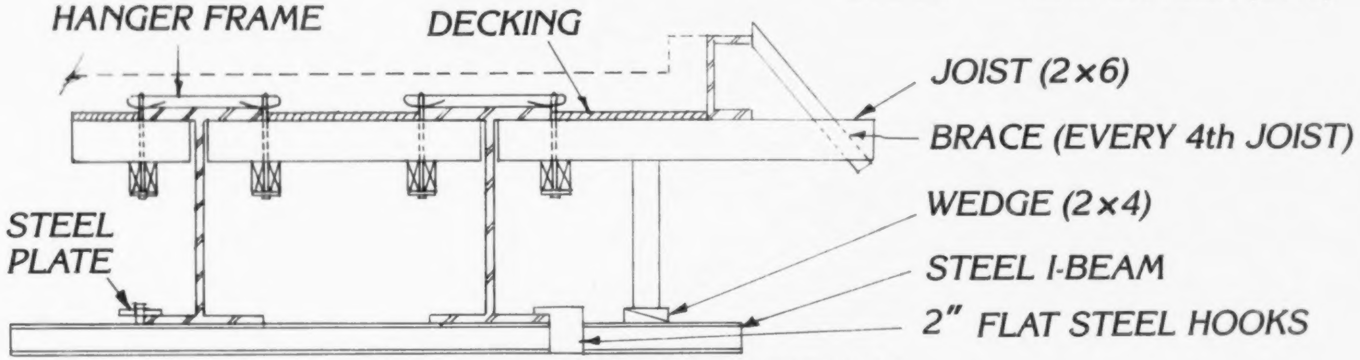

3/4" PLYWOOD DECKING
CHAMFER
EDGE FORM
JOIST
BRACE
DRIP GROOVE
CLEAT
STEEL HANGER OR ALLTHREAD ROD
BRACKET
DUPLEX NAIL
STRINGER OR WALERS
NUT AND WASHER
WOOD FILLER
WOOD BLOCK
SUPPORT

BRACKET AND HANGER

Methods of Supporting Deck Forms

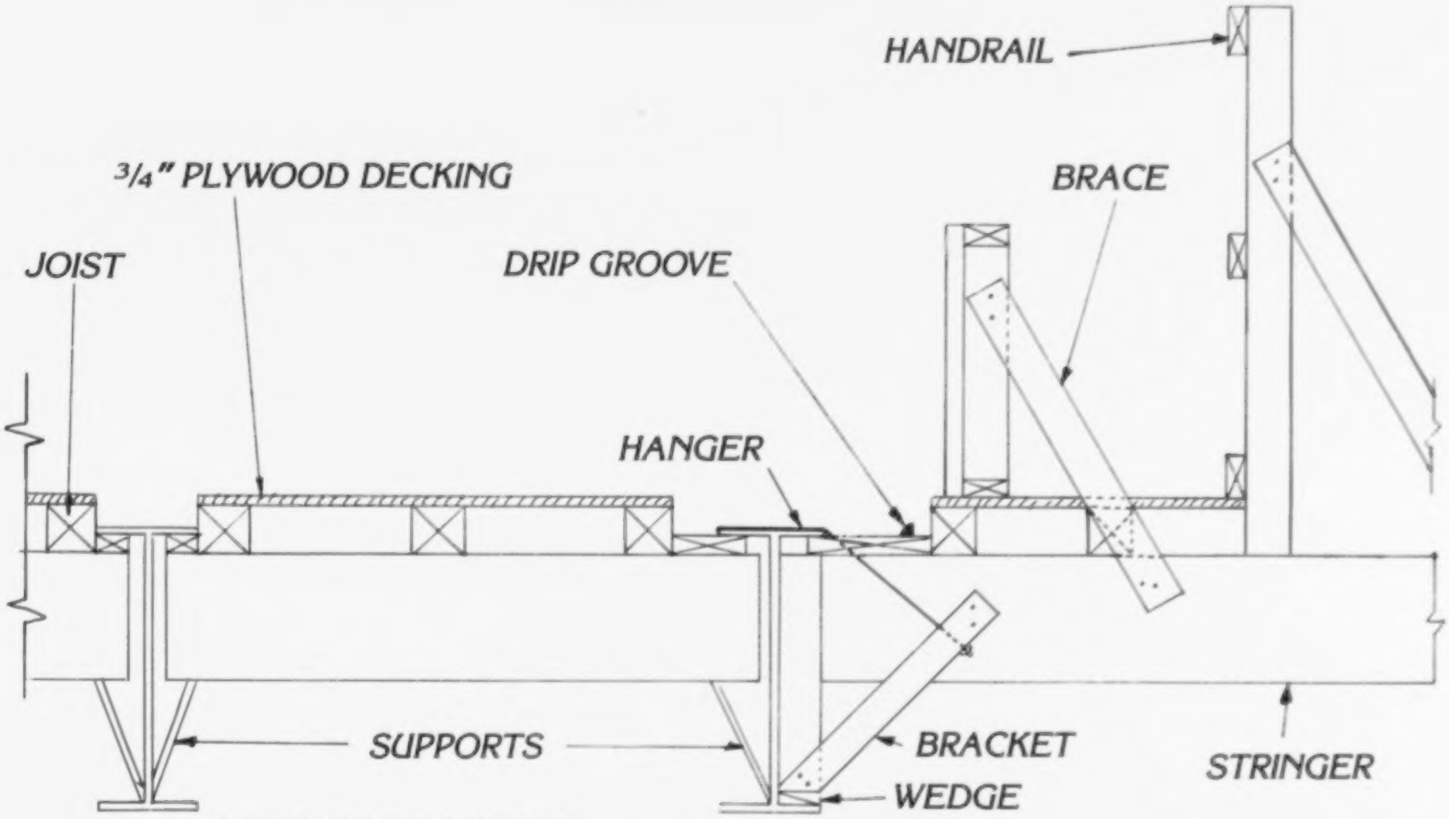

BRACE
DECKING
JOIST
1/2" ALLTHREAD
DOUBLE 2×8 STRINGER OR WALERS
FLAT SPACER (2×8)
FLAT SPACER (2×6)

BRACKET AND HANGER


HANGER FRAME
DECKING
JOIST (2×6)
BRACE (EVERY 4th JOIST)
WEDGE (2×4)
STEEL I-BEAM
STEEL PLATE
2" FLAT STEEL HOOKS

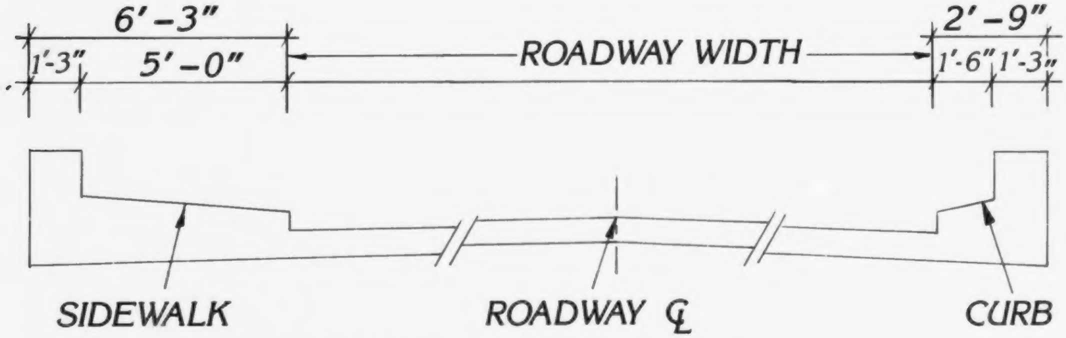
NEEDLE BEAM

Methods of Supporting Deck Forms
(Continued)

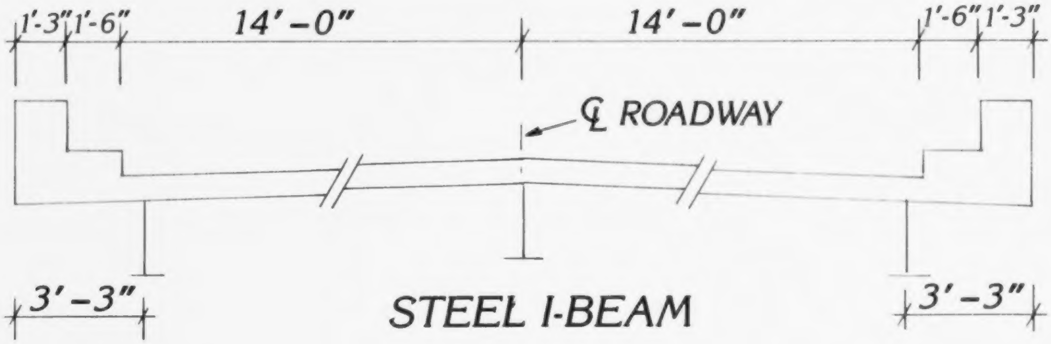

HANDRAIL
3/4" PLYWOOD DECKING
BRACE
JOIST
DRIP GROOVE
HANGER
SUPPORTS
BRACKET
WEDGE
STRINGER

LEG SUPPORTS

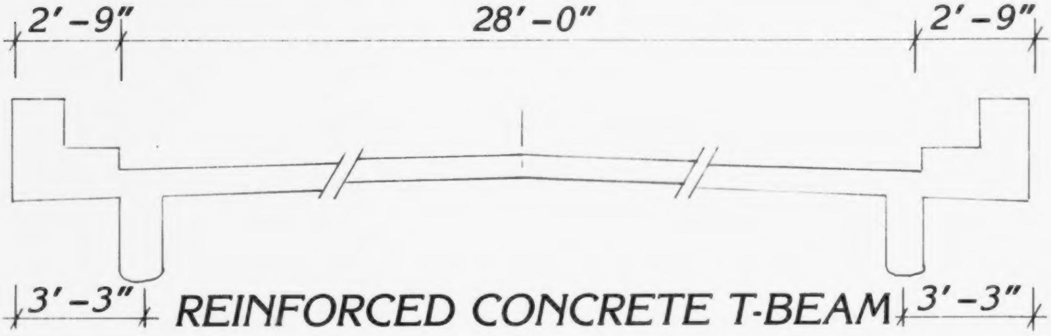
Types of Bridges That Use Reinforced Concrete Slabs


6'-3"
2'-9"
1'-3"
5'-0"
ROADWAY WIDTH
1'-6"
1'-3"
SIDEWALK
ROADWAY ℄
CURB

REINFORCED CONCRETE SLAB


1'-3"
1'-6"
14'-0"
14'-0"
1'-6"
1'-3"
℄ ROADWAY
3'-3"
3'-3"

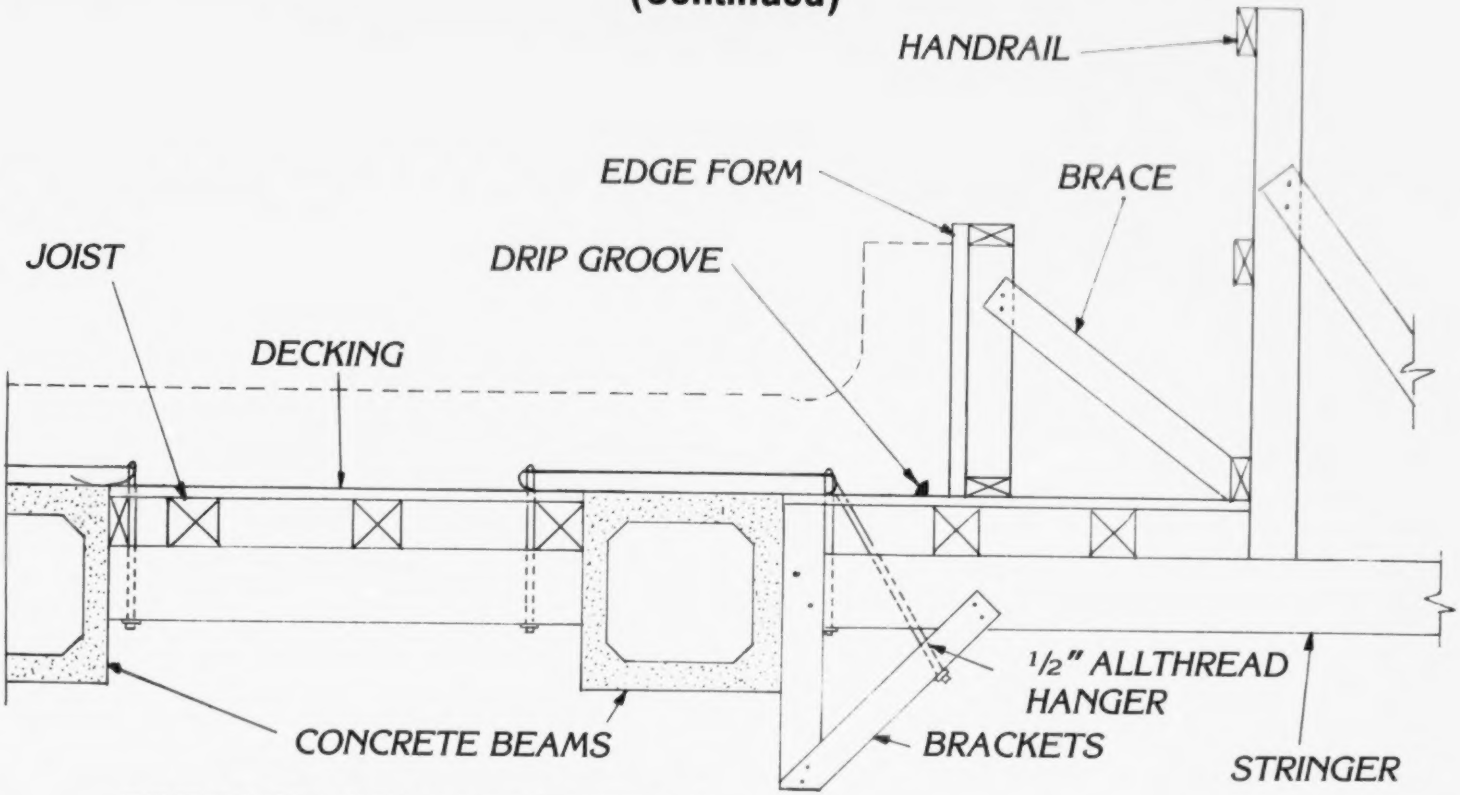
STEEL I-BEAM


2'-9"
28'-0"
2'-9"
3'-3"
3'-3"

REINFORCED CONCRETE T-BEAM

Types of Bridges
That Use Reinforced Concrete Slabs

(Continued)


HANDRAIL
EDGE FORM
BRACE
JOIST
DRIP GROOVE
DECKING
CONCRETE BEAMS
½" ALLTHREAD HANGER
BRACKETS
STRINGER

PRECAST CONCRETE BEAM

BRIDGE DECK FORMS
UNIT XI

INFORMATION SHEET

I. Terms and definitions

A. Bracket — Braced frame used to support deck overhang

B. Coil bolt — Bolt with coarse threads made to fit the helix coil of coil ties and anchors

C. Needle beam — Horizontal support members set on shores or hung

D. Scab — Piece of wood or metal secured across a joint to strengthen and hold the two pieces together

E. Bulkhead — Board placed in a form to cut off the concrete pour

F. Edge form — Low form placed at the perimeter of a slab

G. Slab — Section of concrete larger in its horizontal dimensions than in its thickness

H. Deck — Horizontal sheathing that supports the wet concrete

I. Expansion dam — Part of the bridge that lets it expand and contract with temperature change

J. Scuppers — Steel catch basin located on the low point of the bridge slab which is designed to drain water off the bridge slab

K. Median barrier — Wall projecting from the deck dividing opposite lanes of traffic

L. Backwall — Wall that receives the roadway and connects it to the bridge slab through the expansion joint

M. Diaphragm — Steel spacer beams at intervals on long girders

(NOTE: The diaphragm is perpendicular to the long girders and also supports the concrete at construction joints in the slab.)

N. Screed — Strip of wood or metal used as a guide for leveling or grading a concrete slab

O. Drip groove — Groove in any soffit where the undersurface is exposed to weather; designed to keep water from running back on the soffit

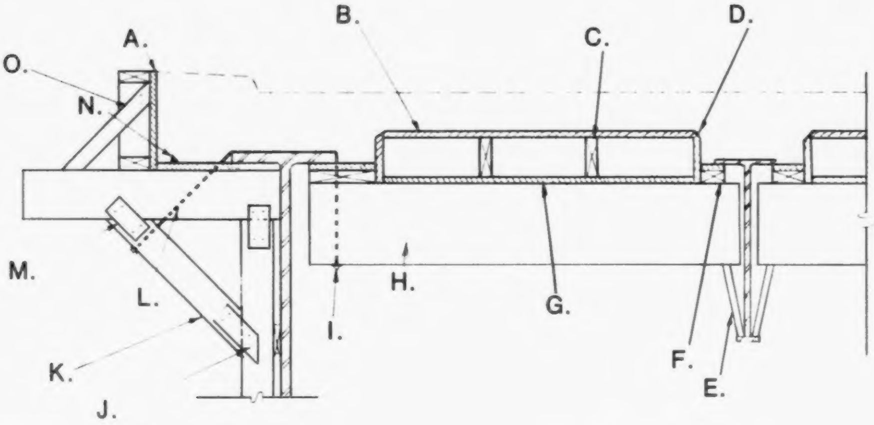
P. Parapet — Longitudinal wall above the surface of the deck which serves as a barrier throughout the length of a bridge

INFORMATION SHEET

II. Parts of a bridge deck form (Figure 1)

- A. Edge form
- B. Plywood decking
- C. Joist
- D. Chamfer
- E. Support
- F. Wood block
- G. Wood filler
- H. Stringer
- I. Nuts and washers
- J. Duplex nails
- K. Bracket
- L. Steel bracket or all thread rod
- M. Cleat
- N. Drip groove
- O. Brace

FIGURE 1



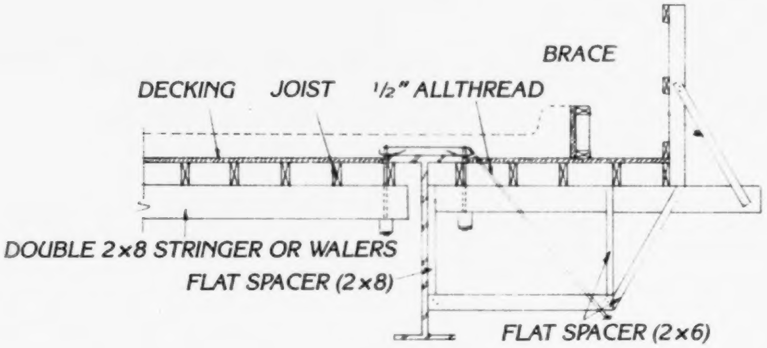
INFORMATION SHEET

III. Methods of supporting deck forms (Figure 2-4)

A. Bracket and hanger

EXAMPLE:

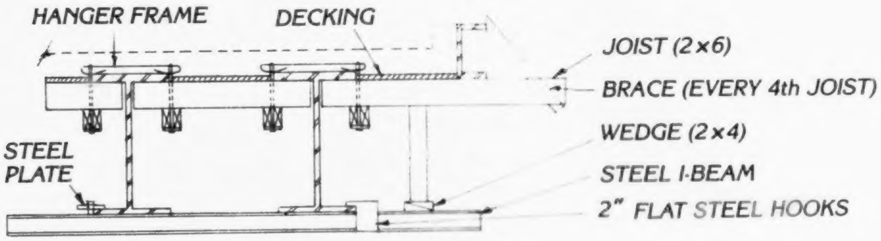
FIGURE 2


BRACE
DECKING
JOIST
1/2" ALLTHREAD
DOUBLE 2×8 STRINGER OR WALERS
FLAT SPACER (2×8)
FLAT SPACER (2×6)

B. Needle beam

EXAMPLE:

FIGURE 3

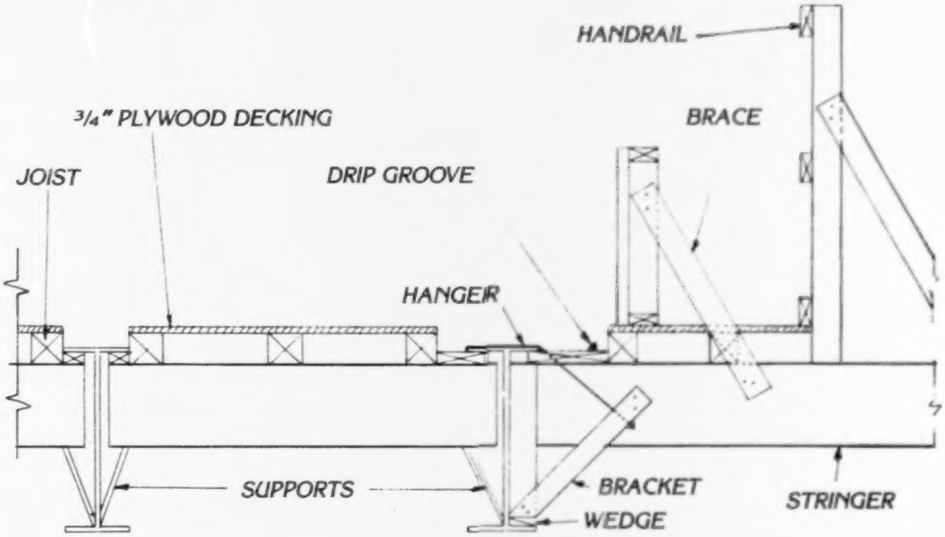

HANGER FRAME
DECKING
JOIST (2×6)
BRACE (EVERY 4th JOIST)
WEDGE (2×4)
STEEL PLATE
STEEL I-BEAM
2" FLAT STEEL HOOKS

INFORMATION SHEET

C. Leg supports

EXAMPLE:

FIGURE 4

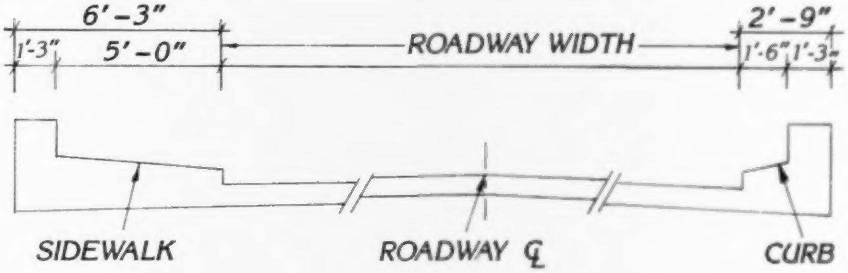

HANDRAIL
3/4" PLYWOOD DECKING
BRACE
JOIST
DRIP GROOVE
HANGER
SUPPORTS
BRACKET
WEDGE
STRINGER

IV. Types of bridges that use reinforced concrete slabs (Figures 5-8)

A. Reinforced concrete slab

EXAMPLE:

FIGURE 5

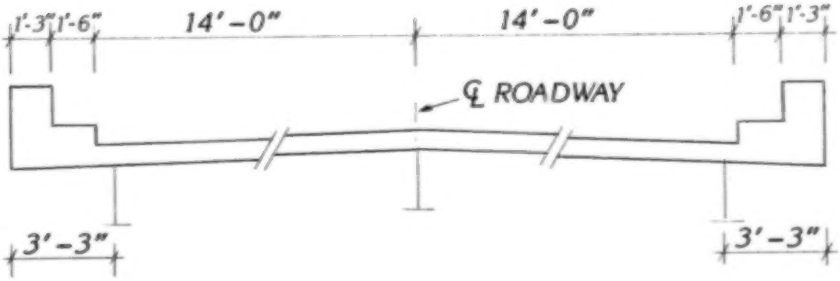

6'-3"
1'-3"
5'-0"
ROADWAY WIDTH
2'-9"
1'-6"
1'-3"
SIDEWALK
ROADWAY ℄
CURB

INFORMATION SHEET

B. Steel I-beam

EXAMPLE:

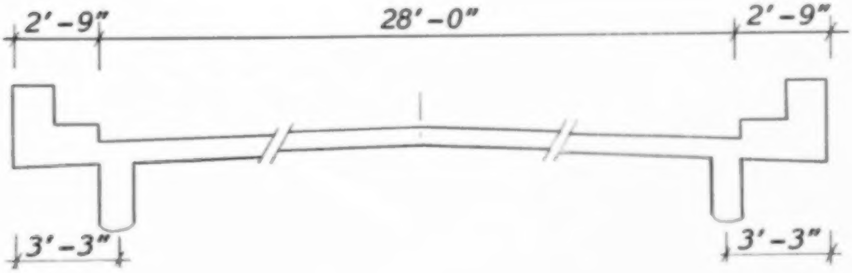
FIGURE 6


1'-3"
1'-6"
14'-0"
14'-0"
1'-6"
1'-3"
℄ ROADWAY
3'-3"
3'-3"

C. Reinforced concrete T-beam

EXAMPLE:

FIGURE 7

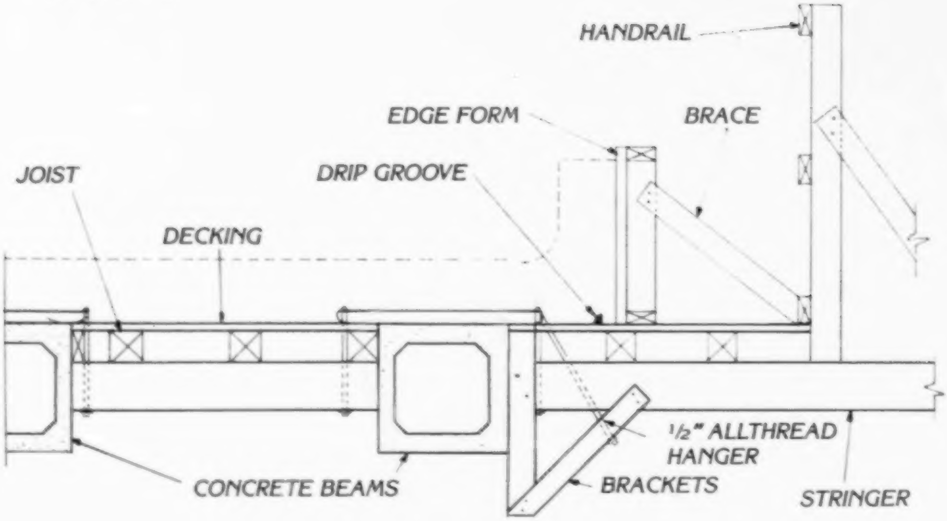

2'-9"
28'-0"
2'-9"
3'-3"
3'-3"

INFORMATION SHEET

D. Precast concrete beam

EXAMPLE:

FIGURE 8


HANDRAIL
EDGE FORM
BRACE
JOIST
DRIP GROOVE
DECKING
½" ALLTHREAD HANGER
CONCRETE BEAMS
BRACKETS
STRINGER

BRIDGE DECK FORMS
UNIT XI

JOB SHEET #1 — CONSTRUCT FORMS FOR A BRIDGE DECK

I. Tools and materials

A. Tools

1. Hammer
2. Handsaw
3. Power handsaw, spare blades, and extension cord
4. Hand level
5. Wrecking bar
6. Chalk line
7. Folding rule or steel tape
8. Combination square
9. Utility knife for cutting expansion joint material

B. Materials

1. Job-built or manufactured brackets
2. Supports
3. Plywood decking
4. 2×6 joists
5. Edge form or parapet
6. Stringer or whaler
7. Soffit
8. Brace
9. Hangers to fit beam size
10. Washers, 4"×4"×1/4"
11. Form bolts, 1/2"

JOB SHEET #1

12. Allthread rod with speed thread, 1/2"
13. Nuts
14. Plastic sleeves for bolts
15. Expansion joint material
16. Water stop
17. Duplex nails, 6d and 16d

II. Procedure

A. Size material

1. Cut stringer material to length and nail together with 3/4-inch spacers
2. Size plywood to proper width
3. Cut joist to correct length
4. Cut soffit to length and notch for bolts at proper spacing

B. Build brackets

1. Build template to conform with bracket shape
2. Cut material to correct length and size
3. Set material in template and nail or bolt
4. Build parapet forms
5. Cut chamfer for exposed edges
6. Cut drip groove

C. Erect deck supports and decking

1. Lay out hanger position on bridge beams
2. Assemble bolts, washers, and beam hangers with nuts
3. Place assembled hangers on bridge beams
4. Hang stringers on bolts in hangers with nuts
5. Place joists and plywood; nail at edge and ends

   (NOTE: Do not overnail because it is difficult to strip. Allow space for soffit form at beam.)

JOB SHEET #1

   6. Bring deck to grade
   7. Place soffit form (wedge or block) to grade and nail
   8. Hang brackets, following steps in D

D. Erect brackets and decking

   1. Hang bracket
   2. Set to proper grade
   3. Lay soffit form in place
   4. Lay joists
   5. Brace joists to keep from rolling
   6. Lay plywood
   7. Lay walkway and erect railing

E. Install edge forms and/or parapet

   1. Locate and strike parapet line
   2. Nail chamfer to line
   3. Set parapet form to line, nailing with 16d duplex nails
   4. Brace top to line
   5. Nail chamfer at top grade

F. Install bridge drain, flashing joints, and expansion dams

(NOTE: Bridge drains are set to line and graded simultaneously with steel on a steel girder.)

   1. Cut drain size hole in deck at proper location
   2. Place drain to line and $^{1}/_{2}$-inch below deck grade to collect water

      (NOTE: Flashing and expansion joint material usually go together. The flashing is installed about 2-inches below grade and there is a groove about $^{3}/_{4}$-inch wide and $^{3}/_{4}$-inch deep. This groove is filled with an epoxy or tar to keep the water from the joint. Expansion dams are steel. The top is set to roadway grade.)

BRIDGE DECK FORMS
UNIT XI

TEST

NAME ______________________________ SCORE ____________

1. Match to their correct definitions terms associated with bridge deck forms. Write the correct numbers in the blanks.

_____a. Braced frame used to support deck overhang

_____b. Bolt with coarse threads made to fit the helix coil of coil ties and anchors

_____c. Horizontal support members set on shores or hung

_____d. Piece of wood or metal secured across a joint to strengthen and hold the two pieces together

_____e. Board placed in a form to cut off the concrete pour

_____f. Low form placed at the perimeter of a slab

_____g. Section of concrete larger in its horizontal dimensions than in its thickness

_____h. Horizontal sheathing that supports the wet concrete

_____i. Part of the bridge that lets it expand and contract with temperature change

_____j. Steel catch basin located on the low point of the bridge slab which is designed to drain water off the bridge slab

_____k. Wall projecting from the deck dividing opposite lanes of traffic

_____l. Wall that receives the roadway and connects it to the bridge slab through the expansion joint

_____m. Steel spacer beams at intervals on long girders

_____n. Strip of wood or metal used as a guide for leveling or grading a concrete slab

1. Needle beam
2. Bulkhead
3. Scab
4. Coil bolt
5. Edge form
6. Bracket
7. Deck
8. Slab
9. Scuppers
10. Parapet
11. Diaphragm
12. Median barrier
13. Drip groove
14. Backwall
15. Screed
16. Expansion dam

TEST

_____o. Groove in any soffit where the undersurface is exposed to weather; designed to keep water from running back on the soffit

_____p. Longitudinal walk above the surface of the deck which serves as a barrier throughout the length of a bridge

2. Identify the parts of the bridge deck form illustrated below. Write the correct numbers in the blanks.

_____a. Brace

_____b. Edge form (parapet)

_____c. Bracket

_____d. Plywood decking

_____e. Wood filler

_____f. Stringer

_____g. Joist

_____h. Duplex nail

_____i. Supports

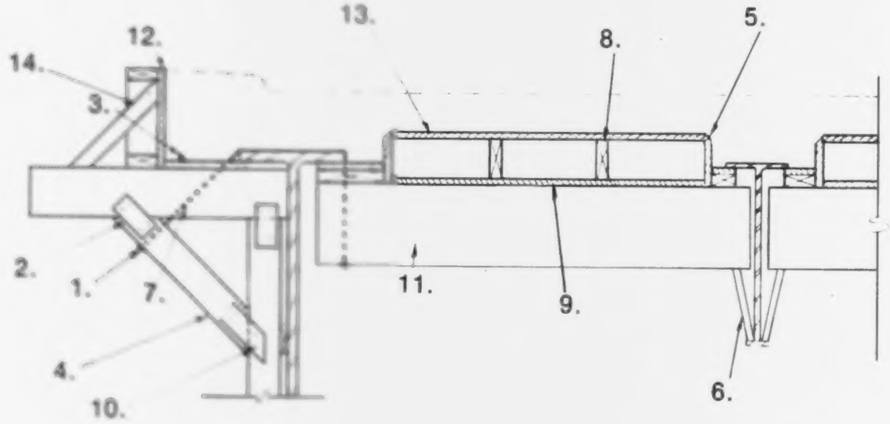
_____j. Cleat

_____k. Steel hangers of allthread rod (with speed thread)

_____l. Washer and nut

_____m. Chamfer

_____n. Drip groove



TEST

3. Name methods of supporting deck forms.

a. ____________________

b. ____________________

c. ____________________

4. Name two types of bridges that use reinforced concrete slabs.

a. ____________________

b. ____________________

(NOTE: Test question 5 lists the job sheet. It is an important part of this test. If it has not been completed, check with your instructor.)

5. Demonstrate the ability to construct forms for a bridge deck.

BRIDGE DECK FORMS
UNIT XI

ANSWERS TO TEST

1. a. 6
   b. 4
   c. 1
   d. 3
   e. 2
   f. 5
   g. 8
   h. 7
   i. 16
   j. 9
   k. 12
   l. 14
   m. 11
   n. 15
   o. 13
   p. 10

2. a. 14
   b. 12
   c. 4
   d. 13
   e. 9
   f. 11
   g. 8
   h. 10
   i. 6
   j. 2
   k. 7
   l. 1
   m. 5
   n. 3

3. a. Bracket and hanger
   b. Needle beam
   c. Leg supports

4. Answer should include any two of the following

   a. Reinforced concrete slab
   b. Steel I-beam
   c. Reinforced concrete T-beam
   d. Precast concrete beam

5. Performance skills evaluated to the satisfaction of the instructor

FLOOR AND SILL FRAMING
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to identify floor and sill framing members and should be able to estimate materials and build floors and sills. The student will show this knowledge by completing the assignment sheet, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with floor and sill framing.
2. Identify floor and sill framing and support members.
3. Name methods used to fasten sills to the foundation.
4. Select from a list types of girders.
5. Determine proper girder size for safe use.
6. List types of joists.
7. Determine proper joist size for ordinary load conditions.
8. Identify types of bridging.
9. List types of subflooring materials.
10. Discuss functional designs used to lay subflooring.
11. List the purposes of subflooring.
12. Match fasteners used in floor framing to their correct uses.
13. Estimate the amount of material needed to frame a floor and sill and to lay a subfloor.
14. Demonstrate the ability to
    a. Build a box sill, install floor joists, and frame an opening.
    b. Install bridging.
    c. Lay diagonal and right-angle subfloors.
    d. Install joists for a cantilever floor.

FLOOR AND SILL FRAMING
UNIT I

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency Master #1 — Types of Joist Hangers

  D. Information sheet

  E. Assignment sheets

    1. Assignment Sheet #1 — Determine Proper Girder Size for Safe Use

    2. Assignment Sheet #2 — Determine Proper Joist Size for Ordinary Load Conditions

    3. Assignment Sheet #3 — Estimate the Amount of Material Needed to Frame a Floor and Sill and to Lay a Subfloor

  F. Answers to assignment sheets

  G. Job sheets

    1. Job Sheet #1 — Build a Box Sill, Install Floor Joists, and Frame an Opening

    2. Job Sheet #2 — Install Bridging

    3. Job Sheet #3 — Lay Diagonal and Right-Angle Subfloors

    4. Job Sheet #4 — Install Joists for a Cantilever Floor

  H. Test

  I. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain materials needed to supplement instruction.

  C. Introduce unit.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Discuss framing and the skills required; review fundamentals according to the needs of your class, emphasizing the various types of saw cuts and methods of nailing, such as end, face, and toenailing.
- Relate floor and sill framing to material previously covered on foundations, stressing that no matter how good the foundation is, a structure will not stand if the floors and sills are poorly assembled.
- Provide the class with articles, brochures, and photographs of building damage that resulted from defective floor and sill framing.

  (NOTE: Architectural engineering publications and organizations can provide such materials regarding inadequate joists, girders, etc. Pest exterminators often have information on termite damage and wood rot.)

D. Provide students with objective sheet.

E. Discuss objective sheet, relating the objectives to commercial carpentry and to your introduction.

F. Provide students with information sheet.

G. Discuss information sheet.

1. Use Information Sheet, Section I to discuss terms associated with floors and sills.

   SUGGESTIONS:

   - Show students actual samples of listed materials whenever possible.

     EXAMPLES: Anchor bolts, steel bridging, sill sealer

   - Relate terms to the objectives, such as making a connection between the term *span* and the objectives on determining proper girder and joist size.
   - Review defects in lumber as discussed in *Fundamentals of Carpentry* when you discuss *crown*. Emphasize the need for solid, sturdy, straight lumber in floor and sill framing, especially for satisfying the requirements of load capacities.

2. Use Information Sheet, Section II to discuss floor and sill framing and support members.

SUGGESTED ACTIVITIES

SUGGESTIONS:

- Make a model showing floor and sill framing; construct the model in such a way that students can disassemble and reassemble it.
- Tour a construction site where the floors and sills are being framed.
- Emphasize the function of each part and introduce the class to the concepts of tables to compute structural load limits and member sizes.
- Relate concepts about the design of footings and foundations studied in previous units to the design of floors and sills.

3. Use Information Sheet, Section III to discuss methods of fastening sills to the foundation.

SUGGESTIONS:

- Show actual samples of the hardware for each method and discuss possible reasons for choosing one over another, especially in specific applications.
- Emphasize safety and the need for certification in the use of powder-actuated fasteners.

4. Use Information Sheet, Sections IV and V to discuss types of girders and how to determine the proper size girder for safe use.

SUGGESTIONS:

- Show the class samples of each type of girder and introduce the students to girder size tables for each type.
- Provide the students with plans specifying the different types of girders, or tour construction sites where various types of girders are being used; discuss reasons for using each type.
- Demonstrate the procedures for determining girder size and allow the students to practice by completing Assignment Sheet #1.
- Review local building codes that affect girder size, use, and materials.
- Motivate the students by emphasizing that plans usually specify girder sizes, but that the sizes must often be adjusted for local regulations, changes requested by the owners, site conditions, and other factors; also point out that often commercial carpenters work on remodelling projects without benefit of engineering prints.

SUGGESTED ACTIVITIES

5. Use Information Sheet, Section VI to discuss types of joists.

   SUGGESTIONS:

   - Provide the class with samples of each type of joist and discuss reasons for using each type, emphasizing local practices.
   - Discuss lumber sizes and lengths that are commonly available.
   - Invite a materials supplier who handles various types of joists to discuss costs, sizes available, time required for special orders, etc.
   - Discuss local regulations affecting joists and floor and sill framing.

6. Use Information Sheet, Section VII to discuss how to determine proper joist size for ordinary load conditions.

   SUGGESTIONS:

   - Demonstrate the procedure for determining proper joist size, emphasizing the variables in the procedure and how changing any of them affects the load capacity; point out, for example, that a smaller size joist can be used if the span is shortened or the spacing made closer.
   - Allow students to complete Assignment Sheet #2.
   - Have the students make cost comparisons of equivalent load-bearing joists, for example, to carry a 40-pound live load over a 16-foot span.
   - Use blueprints to show different ways of handling joist layouts.
   - Demonstrate the procedures in Job Sheets #1 and #4 and allow the students to practice the procedures at a job site or at the training facility.

7. Use Information Sheet, Section VIII to discuss types of bridging.

   SUGGESTIONS:

   - Show samples of each type of bridging and discuss reasons for its use.
   - Invite a framing carpenter to talk to the class about the types of bracing.
   - Discuss spacing, nailing, and other features of bridging installation; use manufacturers' literature to cover steel bridging.
   - Demonstrate the procedures in Job Sheet #2 and allow the students to practice the procedures.

SUGGESTED ACTIVITIES

8. Use Information Sheet, Sections IX through XI to discuss types of subflooring materials, functional designs, and purposes of subflooring.

   SUGGESTIONS:

   - Show samples of each type of flooring and discuss reasons for using each type.
   - Discuss standard sizes, layout, nailing, and other factors involved in subflooring, including local regulations.
   - Invite flooring specialists such as carpet layers and tile setters to discuss subflooring requirements for various types of finish flooring.
   - Demonstrate the procedures in Job Sheet #3 and allow students to practice laying various types of subflooring.
   - Ask students with carpentry experience to discuss the purposes of subflooring, giving examples of each purpose and discussing how subflooring satisfies those purposes.

9. Use Information Sheet, Section XII to discuss types of fasteners used in floor framing.

   SUGGESTIONS:

   - Show the class samples of each type of fastener.
   - Allow the students to practice with any fasteners, including adhesives, not used in the job sheets and related projects.

10. Use Information Sheet, Section XIII to discuss estimating materials for floor and sill framing.

    SUGGESTIONS:

    - Use plans to discuss estimating.
    - Allow students to complete Assignment Sheet #3.
    - Compare costs of material and labor for various types and sizes of joists, girders, and subflooring for a single job.
    - As much as possible, allow students to determine, estimate, and order materials for all projects.

H. Review unit.

I. Give test.

SUGGESTED ACTIVITIES

J. Critique and discuss test in class.

K. Reteach and retest as required.

L. Complete appropriate sections of competency profiles.

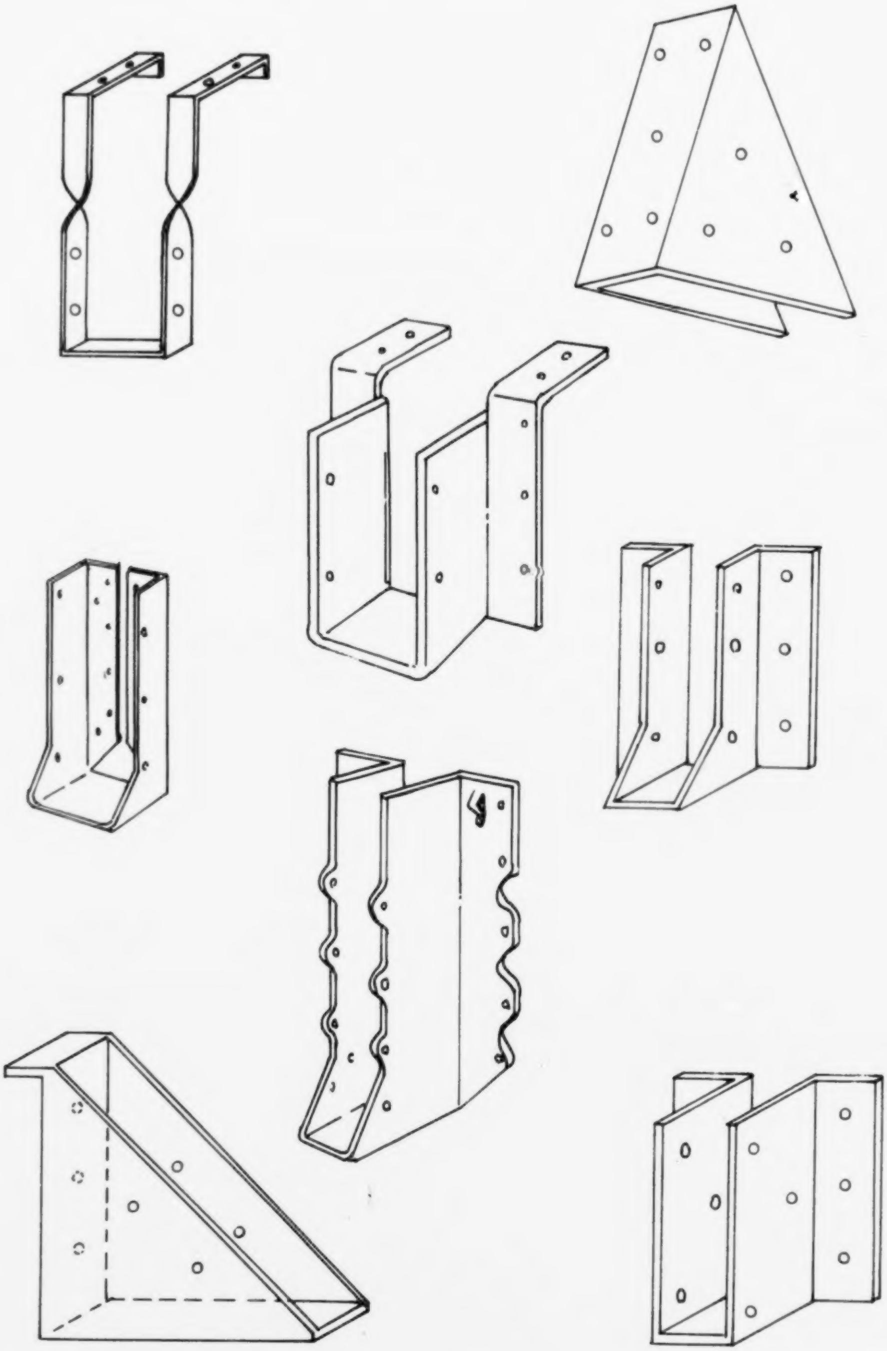
III. Unit references

A. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

B. Penner, Wayman R. *Residential Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1973.

C. Wagner, Willis H. *Modern Carpentry*. New Holland, Illinois: Goodheart-Willcox, 1976.

Types of Joist Hangers



(NOTE: These are only a sample of the many types available.)

FLOOR AND SILL FRAMING
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Sill — Lowest member of structure's frame; rests horizontally on foundation and supports floor joists

B. Foundation — Supporting portion of a structure below the first floor construction, including the footings

C. Joist — One of a series of parallel framing members used to support floor and ceiling loads and supported, in turn, by beams or girders

D. Beam or girder — Any large horizontal piece of timber, precast concrete, iron, or other material used to support concentrated loads at particular points along its length

E. Joist header — Framing member into which common joists are fitted forming the box sill; also used to support free ends of joist when framing openings in floor

F. Bridging — Wood or metal pieces fitted in pairs from bottom of one floor joist to top of adjacent joists, and crossed to distribute floor load; solid stock of same size material as joists may be used

G. Span — Distance between structural supports such as walls, columns, piers, beams, or girders

H. Subfloor — Boards or panels laid directly on floor joists and over which finish floor is laid

I. Joist hanger — Metal stirrup secured to face of structural member to support and align ends of joist flush with member

J. Anchor bolt — Bolt embedded in foundation; used to secure sill to foundation

K. Sill sealer — Resilient, waterproof material used under sill as a seal against air, dirt, and insects

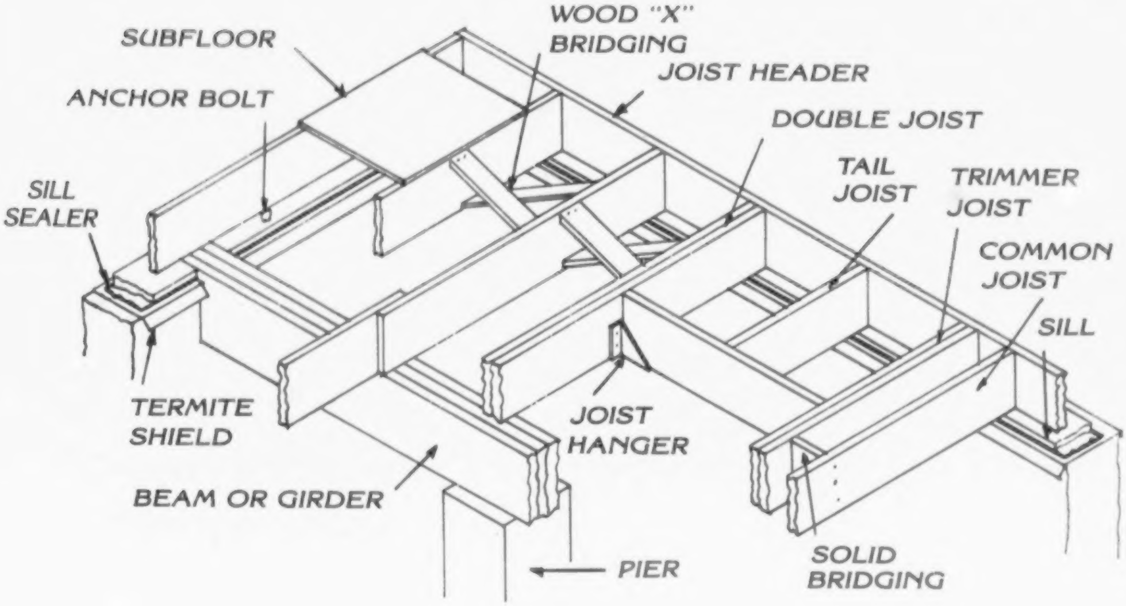
L. Termite shield — Sheet metal placed on foundation wall under sill to prevent passage of termites into structure

M. Crown — High side of curve on edge of framing lumber

INFORMATION SHEET

II. Floor and sill framing and support members (Figure 1)

FIGURE 1


SUBFLOOR
WOOD "X" BRIDGING
JOIST HEADER
ANCHOR BOLT
DOUBLE JOIST
SILL SEALER
TAIL JOIST
TRIMMER JOIST
COMMON JOIST
SILL
TERMITE SHIELD
JOIST HANGER
BEAM OR GIRDER
PIER
SOLID BRIDGING

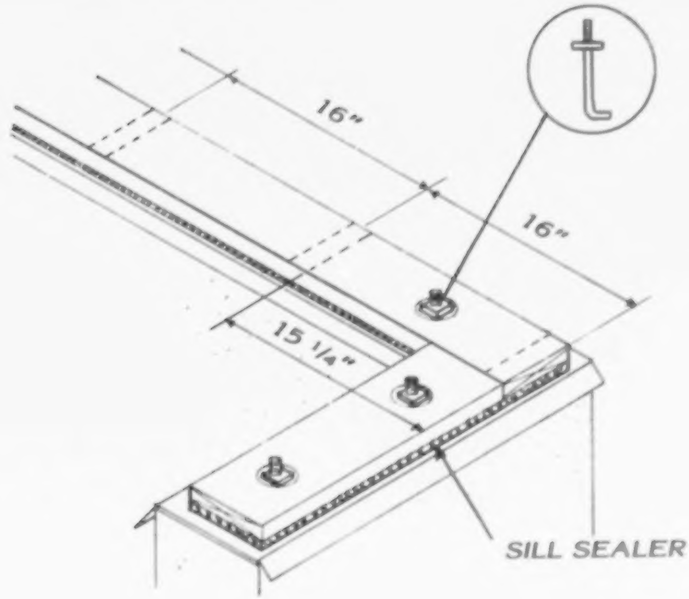
III. Methods used to fasten sills to the foundation (See Figures 2 - 4)

A. Anchor bolts

INFORMATION SHEET

EXAMPLE:

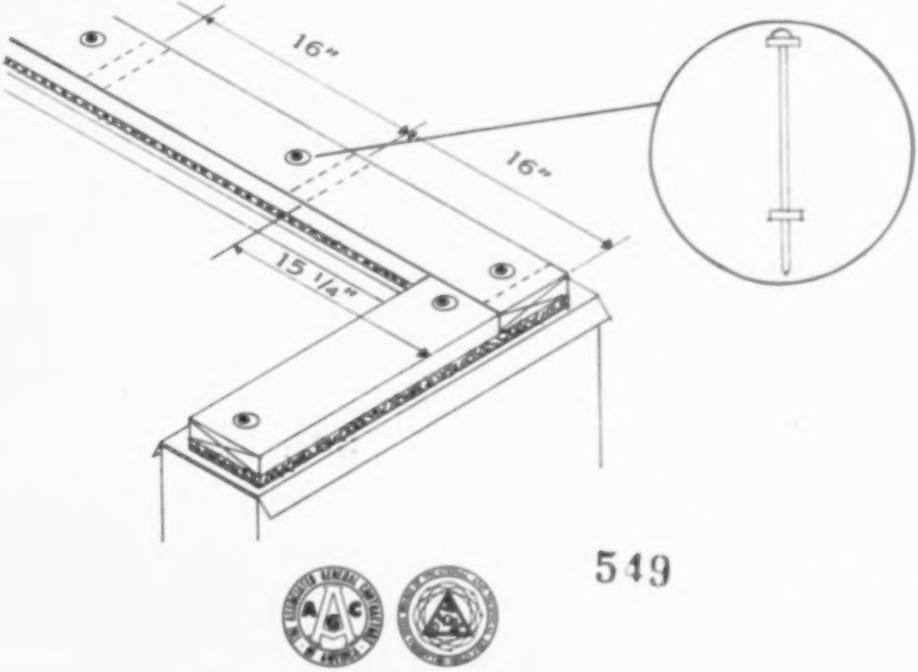
FIGURE 2


16"
16"
15 1/4"
SILL SEALER

B. Powder-actuated pins

EXAMPLE:

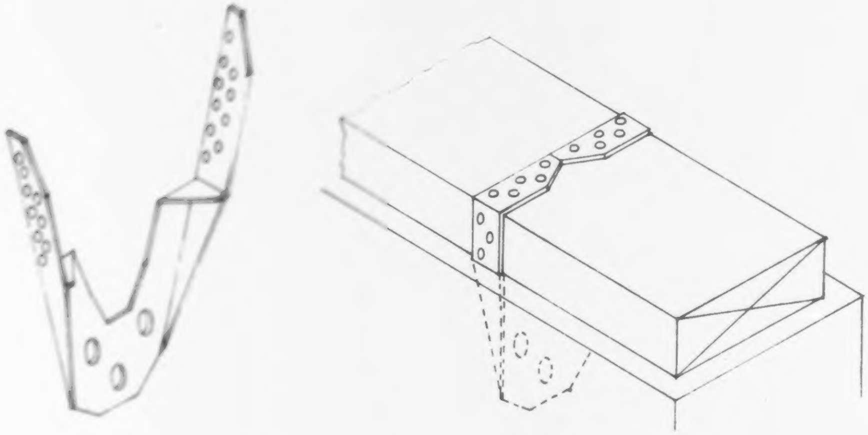
FIGURE 3



C. Metal plates or straps

EXAMPLE:

FIGURE 4



IV. Types of girders

A. Solid timber

B. Built-up timber

C. Steel beam

D. Precast concrete

(NOTE: A load-bearing wall may take the place of a beam or girder.)

V. Determining proper size girders for safe use

A. Determine length of span (distance between girder supports)

B. Determine girder load width

(NOTE: The girder must carry the weight of the floors on each side to the midpoint of the joists that rest upon it.)

INFORMATION SHEET

C. Find total floor load per square foot carried to girder by joists and bearing partitions (See Figure 5)

(NOTE: Total floor load will be the sum of the loads per square foot listed in Table 1, with the exception of roof loads unless braces or partitions are placed under the rafters.)

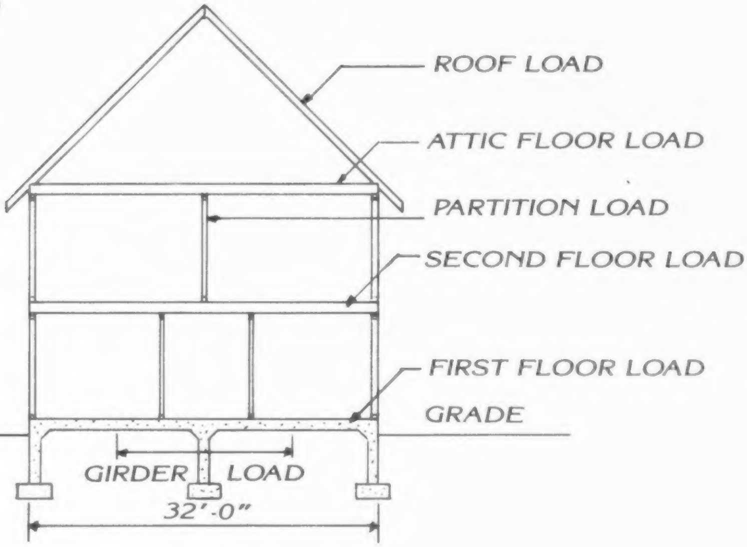
TABLE 1 Girder Load

	Pounds per square foot	
	Live load*	Dead load
Roof	30	10
Attic floor	20	20 (floored) 10 (not floored)
Second floor	40	20
Partitions		20
First floor	40	20 (ceiling plastered) 10 (ceiling not plastered)
Partitions		20

*Usual local requirements

EXAMPLE:

FIGURE 5


ROOF LOAD
ATTIC FLOOR LOAD
PARTITION LOAD
SECOND FLOOR LOAD
FIRST FLOOR LOAD
GRADE
GIRDER
LOAD
32'-0"

INFORMATION SHEET

D. Find total load on girder by multiplying girder span times girder load width times total floor load

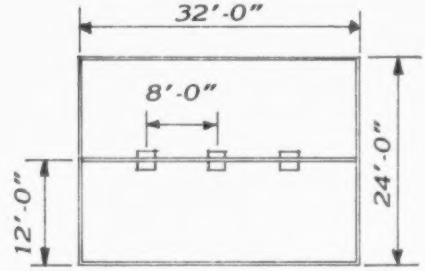
E. Use Table 2 to select proper size girder

(NOTE: Shortening the span is the most economical way to increase the load that a girder will carry.)

TABLE 2 Safe Girder Loads

Nominal Girder Size	Safe load in pounds for spans shown				
	6 Ft	7 Ft	8 Ft	9 Ft	10 Ft
6 × 8 Solid	8,306	7,118	6,220	5,539	4,583
6 × 8 Built up	7,359	6,306	5,511	4,908	4,062
6 × 10 Solid	11,357	10,804	9,980	8,887	7,997
6 × 10 Built up	10,068	9,576	8,844	7,878	7,086
8 × 8 Solid	11,326	9,706	8,482	7,553	6,250
8 × 8 Built up	9,812	8,408	7,348	6,544	5,416
8 × 10 Solid	15,487	14,732	13,608	12,116	10,902
8 × 10 Built up	13,424	12,968	11,792	10,504	9,448

EXAMPLE: Determine girder requirements for first-floor plan shown using built-up girders if the ceilings are drywall.



1. Span is 8'-0".
2. Girder load width is 12'-0" (6'-0" on each side).
3. Total floor load per square foot from Table 1 is 50 pounds per square foot (40 pounds + 10 pounds).
4. Total load on girder is 8' × 12' × 50 pounds per square foot = 4800 pounds.
5. From Table 2 a built-up girder with an 8-foot span must be 6 × 8 to carry a 4800-pound load.

INFORMATION SHEET

VI. Types of joists

- A. Solid wood
- B. Fabricated wood
- C. Steel bar
- D. Steel "C"
- E. Reinforced concrete

VII. Determining proper joist size for ordinary load conditions

- A. Find length of span
- B. Determine live load per square foot
- C. Determine if ceiling below is to be plastered
- D. Use Table 3 to select proper size joist

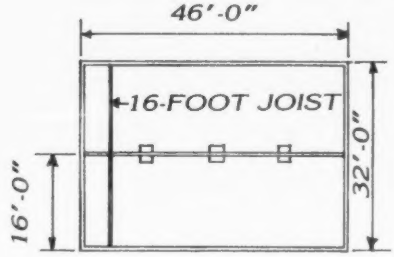
(NOTE: Table 3 shows maximum safe spans for wood joists under ordinary load conditions.)

TABLE 3 Safe Joist Spans

		Spans for live loads shown			
Nominal Joist Size	30# Spacing	40# Live load	50# Live load	60# Live load	70# Live load
2×6	12″	14′-10″	13′-2″	12′-0″	11′-1″
	16″	12′-11″	11′-6″	10′-5″	9′-8″
	24″	10′-8″	9′-6″	8′-7″	7′-10″
2×8	12″	19′-7″	17′-5″	15′-10″	14′-8″
	16″	17′-1″	15′-3″	13′-10″	12′-9″
	24″	14′-2″	12′-6″	11′-4″	10′-6″
2×10	12″	24′-6″	21′-10″	19′-11″	18′-5″
	16″	21′-6″	19′-2″	17′-5″	16′-1″
	24″	17′-10″	15′-10″	14′-4″	13′-3″
2×12	12″	29′-4″	26′-3″	24′-0″	22′-2″
	16″	25′-10″	23′-0″	21′-0″	19′-5″
	24″	21′-5″	19′-1″	17′-4″	16′-0″
3×8	12″	24′-3″	21′-8″	19′-10″	18′-4″
	16″	21′-4″	19′-1″	17′-4″	16′-0″
	24″	17′-9″	15′-9″	14′-4″	13′-3″
3×10	12″	30′-2″	27′-1″	34′-10″	23′-0″
	16″	26′-8″	23′-10″	21′-9″	20′-2″
	24″	22′-3″	19′-10″	18′-1″	16′-8″

INFORMATION SHEET

EXAMPLE: The plan below falls into the 40-pound live load category and will be built with joists on 16-inch centers and drywall ceilings.



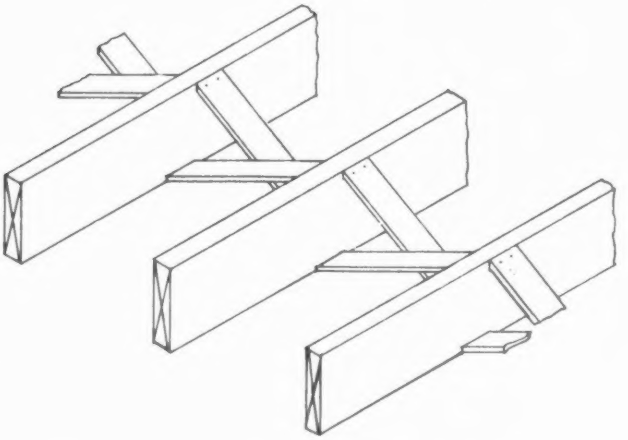
1. Span is 16'.
2. Live load per square foot is 40 pounds.
3. The ceiling will not be plastered.
4. Table 3 shows that a 2 × 10 joist 16 inches o.c. will carry the load up to a span of 19'-2".

   (NOTE: A 2 × 8 joist 16 inches o.c. will carry the required load up to 15'- 3", which is not long enough for the required span.)

VIII. Types of bridging (Figures 6 - 8)

A. Wood "X" bridging (regular bridging)

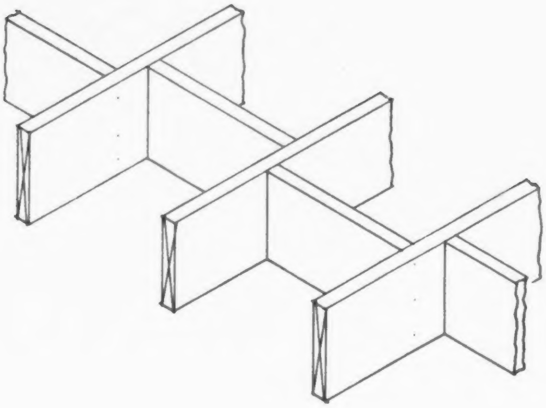
FIGURE 6



INFORMATION SHEET

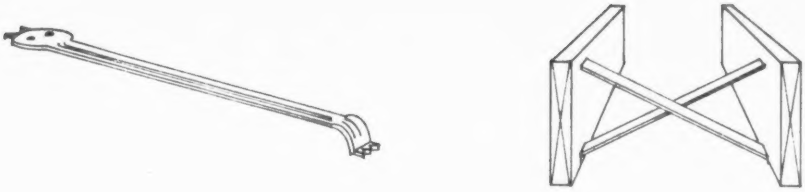
B. Solid wood

FIGURE 7



C. Steel

FIGURE 8



IX. Types of subflooring materials

- A. Shiplap lumber
- B. Tongue-and-groove lumber
- C. Common lumber
- D. Plywood
- E. Fiberboards
  - 1. Wafer board
  - 2. Strand board
  - 3. Particle board

INFORMATION SHEET

X. Functional designs used to lay subflooring

   A. Subflooring laid diagonally to joists

      1. May be used to lay shiplap, tongue-and-groove, or common lumber

      2. Permits finish floor to be laid in any direction

      3. Provides better than average bracing and stiffness to building

      4. Is preferred in buildings of two or more stories

      (NOTE: In structures in which diagonal subflooring is used, the subfloor boards run in opposite diagonal directions on alternate floors to provide better bracing.)

   B. Subflooring laid at right angles to joists

      1. May be used to lay any of the subfloor materials

      (NOTE: Most subflooring today is tongue-and-groove or square-edge plywood. Plywood subfloors provide many advantages over lumber subfloors. They are versatile, inexpensive as compared to lumber subfloors, and require the least amount of labor time [see Table 4]. Plywood subfloors may also be fastened to the joists with a pneumatic stapler or pneumatic nailer, thus making ease of installation another advantage.)

      2. Requires that finish floor run parallel to joists (be laid at right angle to subfloor)

      3. Provides average bracing and stiffness to building

      4. Generally results in less waste than diagonal subfloors

      5. Requires less labor time to install than diagonal subfloors

      EXAMPLE:

TABLE 4 Labor time for installing subfloor

Type of subfloor	Board feet installed per hour
Tongue-and-groove lumber	55
Diagonal lumber	65
Right-angle lumber	75
Plywood	100

INFORMATION SHEET

XI. Purposes of subflooring

- A. Lending bracing strength to building
- B. Providing solid base for finish floor, thus making floor sag and squeaks less likely
- C. Acting as barrier to cold and dampness, thus keeping building warmer and drier in winter
- D. Providing a safe working surface for constructing the building

XII. Fasteners used in floor framing and their uses

- A. 16d box nails — Used to attach header to joist, install solid bridging, and to construct beams and girders
- B. Special nails — Furnished to attach joist hangers
- C. 8d box nails — Used to install wood "X" bridging and subfloor
- D. Pneumatic, ring shank, and screw nails — Used to apply subfloor
- E. Construction glue or adhesive — Used to install subfloor, sheathing, wall paneling, and siding

  (NOTE: Glued subfloors are more stable than nailed subfloors. They are less noisy and are squeak free.)

XIII. Estimating materials

- A. Check building specificiations for kinds and dimensions of materials
- B. Use plans to check dimensions
  1. Sill sealer — Lineal feet
  2. Termite shield — Lineal feet
  3. Sill — Size, lineal feet
  4. Beams or girders — Size, lineal feet
  5. Joists — Number, size, length
     - a. Determine length needed and round up to next highest even foot

INFORMATION SHEET

b. Determine number of joists needed

1) For 16 inches on center, multiply length of building by 3/4, and add one joist for end and one joist for each partition that runs parallel to joists

2) For 24 inches on center, multiply length of building by 1/2, and add one joist for end and one joist for each partition that runs parallel to joists

6. Joist headers — Size, lineal feet

(NOTE: Allow enough for twice the length of the building and all openings.)

7. Bridging

(NOTE: One row of bridging is required in spans over 8 feet and less than 16 feet in length. Two rows of bridging are required in spans over 16 feet.)

a. Wood "X" bridging — Lineal feet

(NOTE: Bridging is usually cut from 1×4 rough lumber.)

1) Determine number of rows of bridging needed

2) Determine length of each row of bridging

3) Multiply total lineal footage of bridging rows by appropriate factor from Table 5 to get total lineal feet of bridging needed

TABLE 5

Joist size (nominal)	Spacing (inches) on center)	Lineal feet of material (per foot of bridging row)
2×6 to 2×10	16	2
2×12	16	2 1/4
2×14	16	2 1/2

(NOTE: If the joists are 24 inches on center, the total lineal footage of bridging rows is equal to the number of pieces of bridging material needed.)

INFORMATION SHEET

b. Steel bridging — Number of each for joists 16 inches on center

   1) Determine number of rows of bridging needed

   2) Determine length of each row of bridging

   3) Multiply total lineal footage of bridging rows by 3/4 to find the number of spaces between joists 16 inches on center

   4) Multiply above product by 2 to determine total number of pieces needed

   (NOTE: If the joists are 24 inches on center, the total lineal footage of bridging rows is equal to the number of pieces of bridging material needed.)

c. Solid lumber bridging — Lineal feet

   1) Determine number of rows of bridging needed

   2) Determine length of each row of bridging

   3) Multiply number of rows by length of each row to determine total lineal feet needed

8. Subflooring

   a. Lumber — Board feet

      1) Calculate area of entire floor to be covered, ignoring small openings in floor

      2) Calculate amount of material allowed for waste, using Table 6, and add to total area

TABLE 6

Material	Allowance when laid at right angles to joists, %	Allowance when laid diagonally, %
1×6 tongue-and-groove	20	25
1×8 tongue-and-groove	15	20
1×6 shiplap	20	25
1×8 shiplap	15	20
1×6 square edge	12	17
1×8 square edge	10	15

(NOTE: Rule of thumb: for 1×6 lumber, add to the total area 1/6 for waste; for 1×8 lumber, add 1/8 for waste.)

INFORMATION SHEET

b. Plywood — Square feet or number of pieces

   1) Calculate area of entire floor

   2) Divide square feet of floor area by total square feet in one sheet of plywood (32)

   3) Round any fractional sheets to next whole sheet

FLOOR AND SILL FRAMING
UNIT I

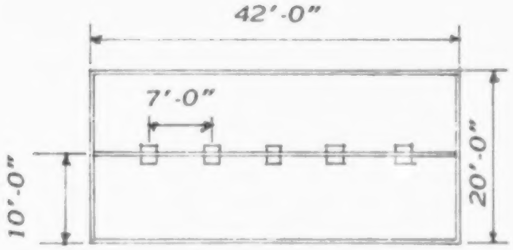
ASSIGNMENT SHEET #1 — DETERMINE PROPER GIRDER SIZE FOR SAFE USE

NAME ______________________________ SCORE ____________

In structures with perimeter foundations, much of the structural load must be carried by girders. If the girders are unable to carry the load, damage to the structure is likely and collapse is possible. Thus, a carpenter must be sure that girders used meet the requirements for safe use.

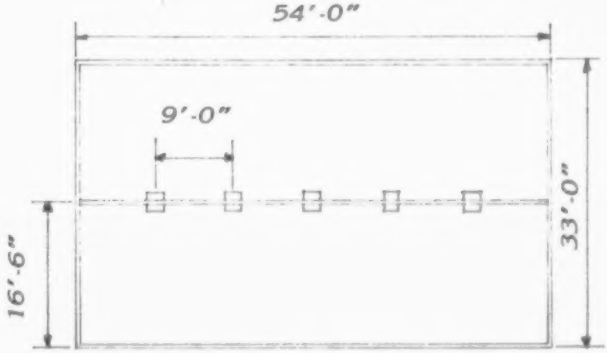
Use the information and tables in Section V of the information sheet to compute the proper girder size for each situation described.

A. In the plan below, solid timber girders will be used and the ceilings will be plastered.



Girder size ____________

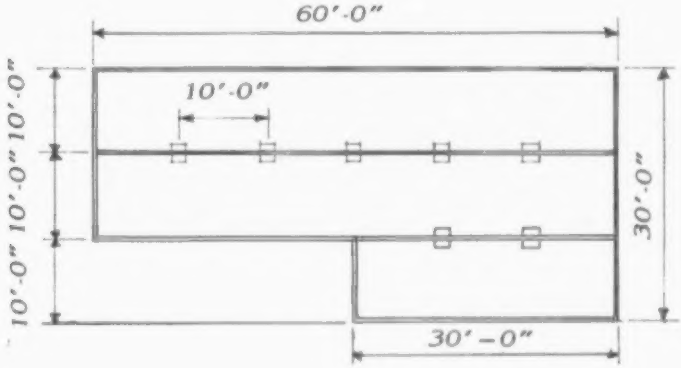
B. Built-up girders and drywall ceilings are to be used in the plan below.



Girder size ____________

ASSIGNMENT SHEET #1

C. The plan below will be constructed using built-up girders and drywall ceilings.


60'-0"
10'-0"
10'-0"
10'-0"
10'-0"
30'-0"
30'-0"

Girder size ____________

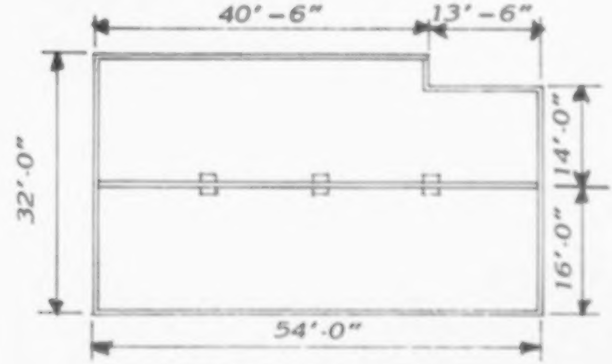
FLOOR AND SILL FRAMING
UNIT I

ASSIGNMENT SHEET #2 — DETERMINE PROPER JOIST SIZE FOR ORDINARY LOAD CONDITIONS

NAME ______________________________ SCORE ______________

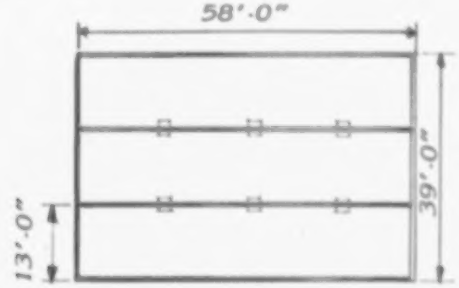
Joists are used to distribute the weight of the structure over the support provided by the foundation and girders. Each joist is required to carry a certain portion of the total load of the structure. For the building to remain standing without damage, each joist must be able to carry its share of the load. To ensure that this critical function is met, the carpenter must be able to determine the correct joist size for the structural load. Using the information in Section VII of the information sheet, determine the proper joist size for the situations given.

A. This plan is designed so that the structure has a 50-pound live load with its plaster ceiling. What size joist is required if the joists are spaced 24 inches O.C.?



Joist size ____________

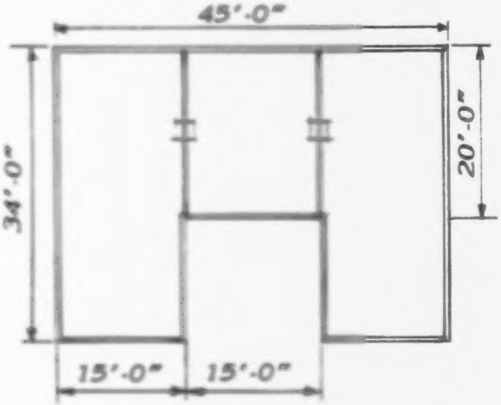
B. In the plan below, a drywall ceiling will be used. The structure is in the 40-pound live load category with joists 16 inches O.C. What size joist is required?



Joist size ____________

ASSIGNMENT SHEET #2

C. This plan calls for a drywall ceiling and joists 24 inches O.C. The joists will carry a live load of 40 pounds per square foot. What size joist is required?



Joist size ______________

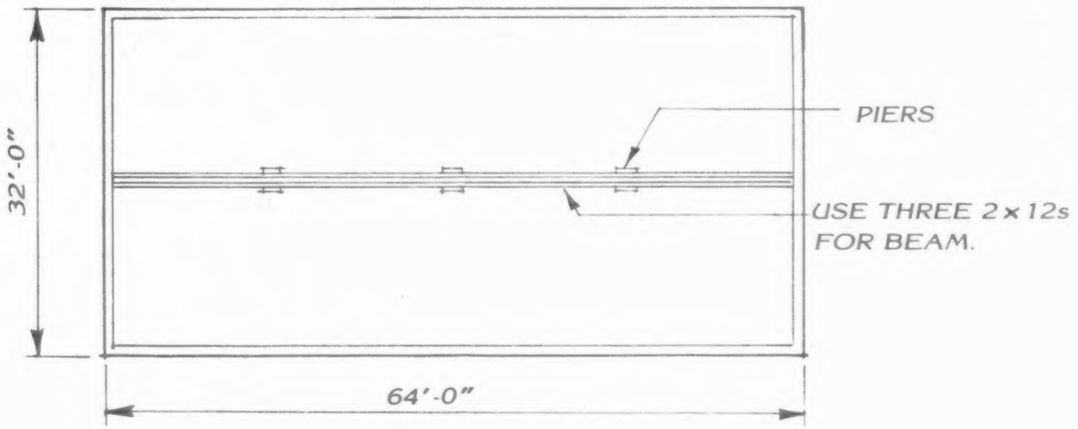
FLOOR AND SILL FRAMING
UNIT I

ASSIGNMENT SHEET #3 — ESTIMATE AMOUNT OF MATERIAL NEEDED TO FRAME A FLOOR AND SILL AND TO LAY A SUBFLOOR

NAME ______________________________ SCORE ______________

Because of the importance of the floor in carrying the weight of the structure, it is important that a carpenter be able to correctly determine the materials required. The carpenter must be able to recognize special needs such as those for openings, cantilevers, and partition support that affect material requirements. Once the needs are determined, the carpenter must be able to estimate the quantities of materials needed in order to continue the project without delays or added expense from too much material.

Using the information sheet, calculate the floor and sill framing materials needed for the building depicted below. Set joists on sixteen-inch centers. The plans call for solid lumber bridging and plywood subflooring.



__________ A. Sill sealer

__________ B. Termite shield flashing

__________ C. Sill

__________ D. Beams or girders

__________ E. Joists

__________ F. Joist headers

ASSIGNMENT SHEET #3

_____________ G. Bridging (solid lumber)

_____________ H. Subflooring, plywood (number of 4×8 pieces)

FLOOR AND SILL FRAMING
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A. 6×8

B. 6×10

C. 6×10

Assignment Sheet #2

A. 2×12

B. 2×8

C. 2×10

Assignment Sheet #3

A. 192 lineal feet

B. 192 lineal feet

C. 192 lineal feet

D. 192 lineal feet of 2×12s or one beam 6×12×64′

E. 98—2×12s 16′ long

F. 128 lineal feet of 2×12s

G. 128 lineal feet of 2×12s

H. 64 pieces

FLOOR AND SILL FRAMING
UNIT I

JOB SHEET #1 — BUILD A BOX SILL, INSTALL FLOOR JOISTS, AND FRAME AN OPENING

I. Tools and materials

A. Tools

1. Power handsaw and extension cord
2. Electric hand drill
3. Flat bit, 5/8"
4. Tin snips
5. Claw hammer
6. Framing square
7. Level
8. One-hundred-foot tape
9. Folding rule or steel tape
10. Saber or reciprocating saw
11. Adjustable wrench

B. Materials

1. Sill sealer
2. Flashing for termite shield
3. Beam material
4. 2×6s for sills
5. 2×10s for joists and headers
6. 1×4s or solid lumber for bridging
7. 8d box nails for bridging
8. 16d box nails for joists and headers
9. Grout
10. Shim materials

JOB SHEET #1

II. Procedure

A. Check foundation for square and level

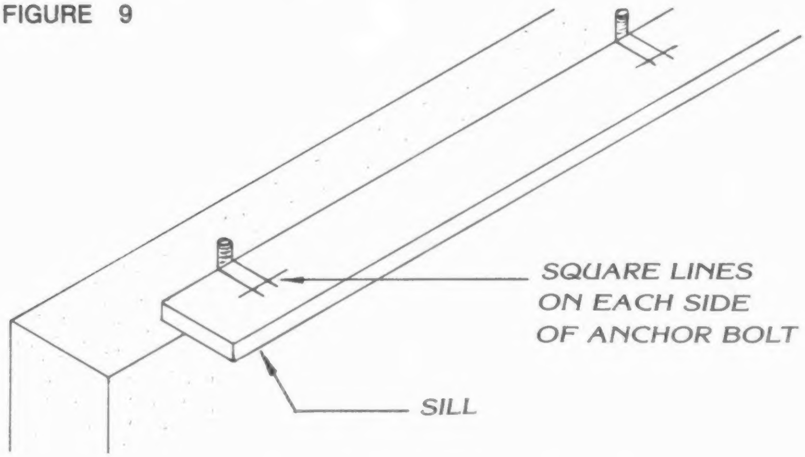
B. If foundation is not level, use grout to level it

C. Strike lines on foundation

D. Lay 2×6 sill material on top of foundation as shown in Figure 9; mark location of sill anchors and cutouts for girders and other construction features

E. Locate hole centers on sill (Figure 9)

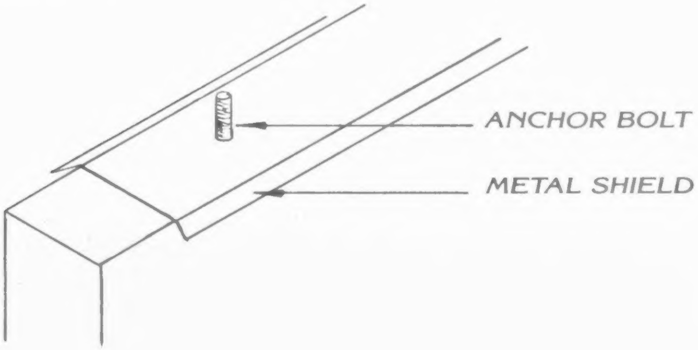
FIGURE 9


SQUARE LINES
ON EACH SIDE
OF ANCHOR BOLT
SILL

F. Drill 5/8-inch holes through sill at anchor bolt locations

G. Cut flashing for termite shield to length, shape as shown in Figure 10, cut holes for anchor bolts, and place shield on top of foundation

FIGURE 10

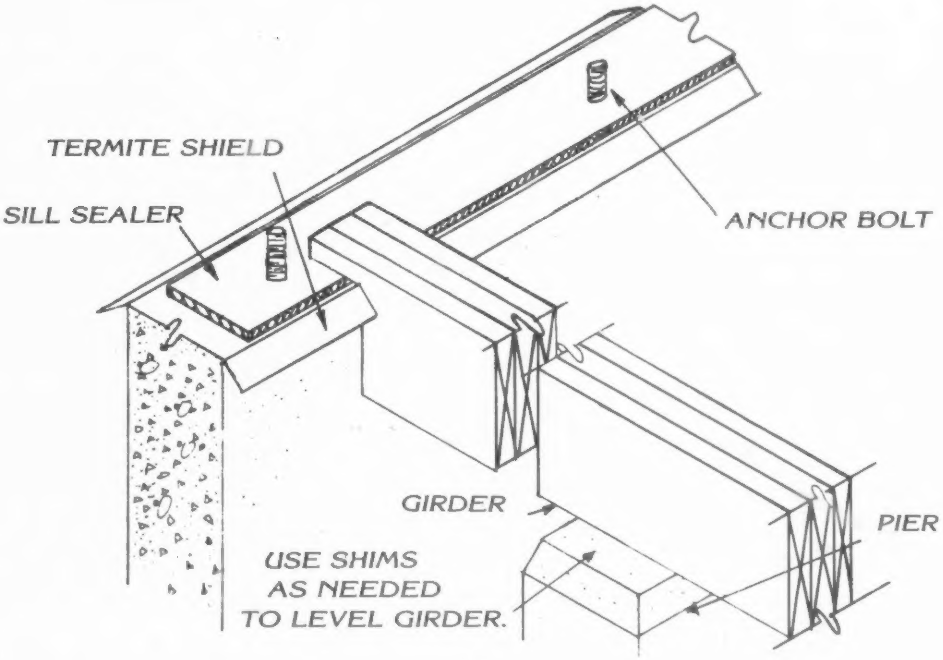

ANCHOR BOLT
METAL SHIELD

H. Cut sill sealer to length and lay on top of termite shield

JOB SHEET #1

I. Build beam or girder, if one is necessary, and place it in position on piers, using shims as necessary to level it (Figure 11)

FIGURE 11


TERMITE SHIELD
SILL SEALER
ANCHOR BOLT
GIRDER
PIER
USE SHIMS AS NEEDED TO LEVEL GIRDER.

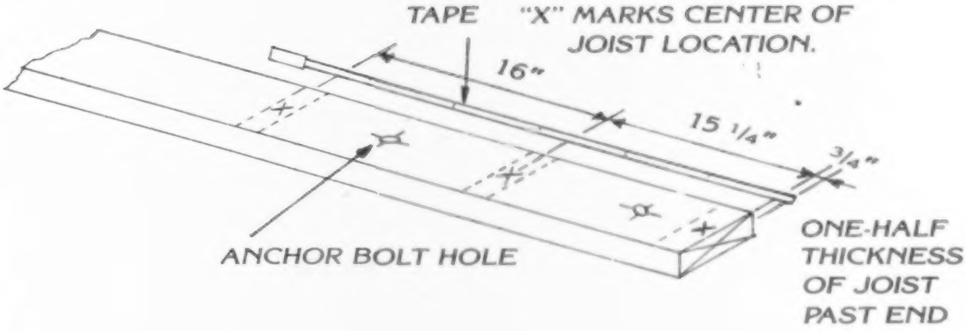
J. Lay off sill for floor joists on 16-inch centers

1. Start at one end using 100-foot tape marked for 16-inch centers

2. Hold end of tape half the thickness of a 2×10 past end of sill; mark sill every 16 inches for full length, repeating the operation for other end of joist at girder or opposite sill (See Figure 12)

JOB SHEET #1

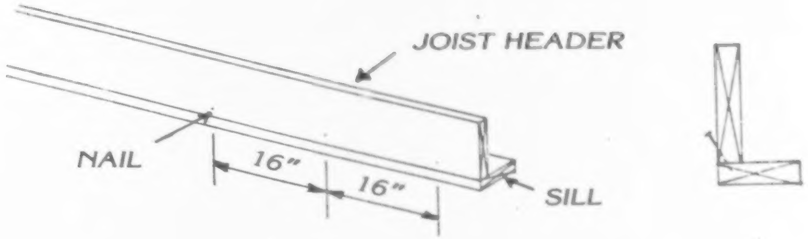
FIGURE 12


TAPE
"X" MARKS CENTER OF JOIST LOCATION.
16"
15 1/4"
3/4"
ANCHOR BOLT HOLE
ONE-HALF THICKNESS OF JOIST PAST END

3. Mark and cut sill to allow for girders and other structural features

K. Cut joist headers to length and toenail to sill with 16d box nails to form box sill (Figure 13)

FIGURE 13


JOIST HEADER
NAIL
16"
16"
SILL

L. Place sill and box sills on top of termite shield all around perimeter of the structure

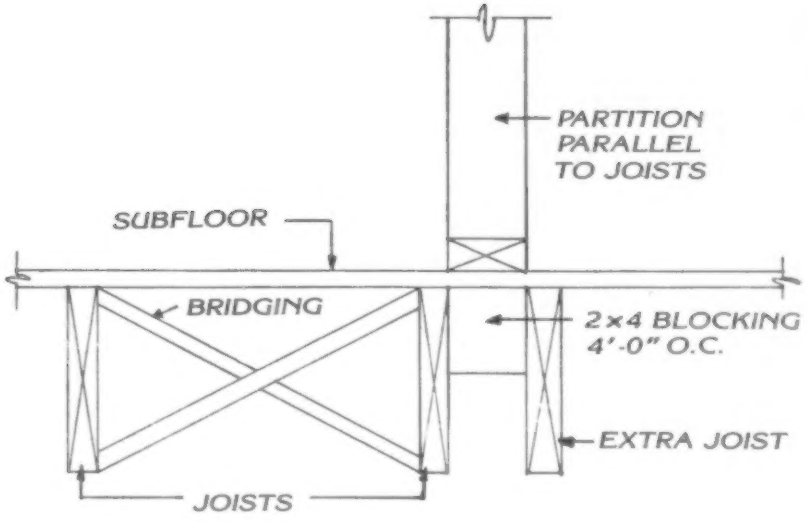
M. Attach nut to anchor bolt and tighten

N. Distribute floor joists at every spot marked on sill; sight along edge of each joist, and lay joist on sill with crown up

O. Add an extra joist on opposite side of partition wall locations from joist nearest to partition wall that runs parallel to joists (See Figure 14; see also Figure 15)

JOB SHEET #1

FIGURE 14

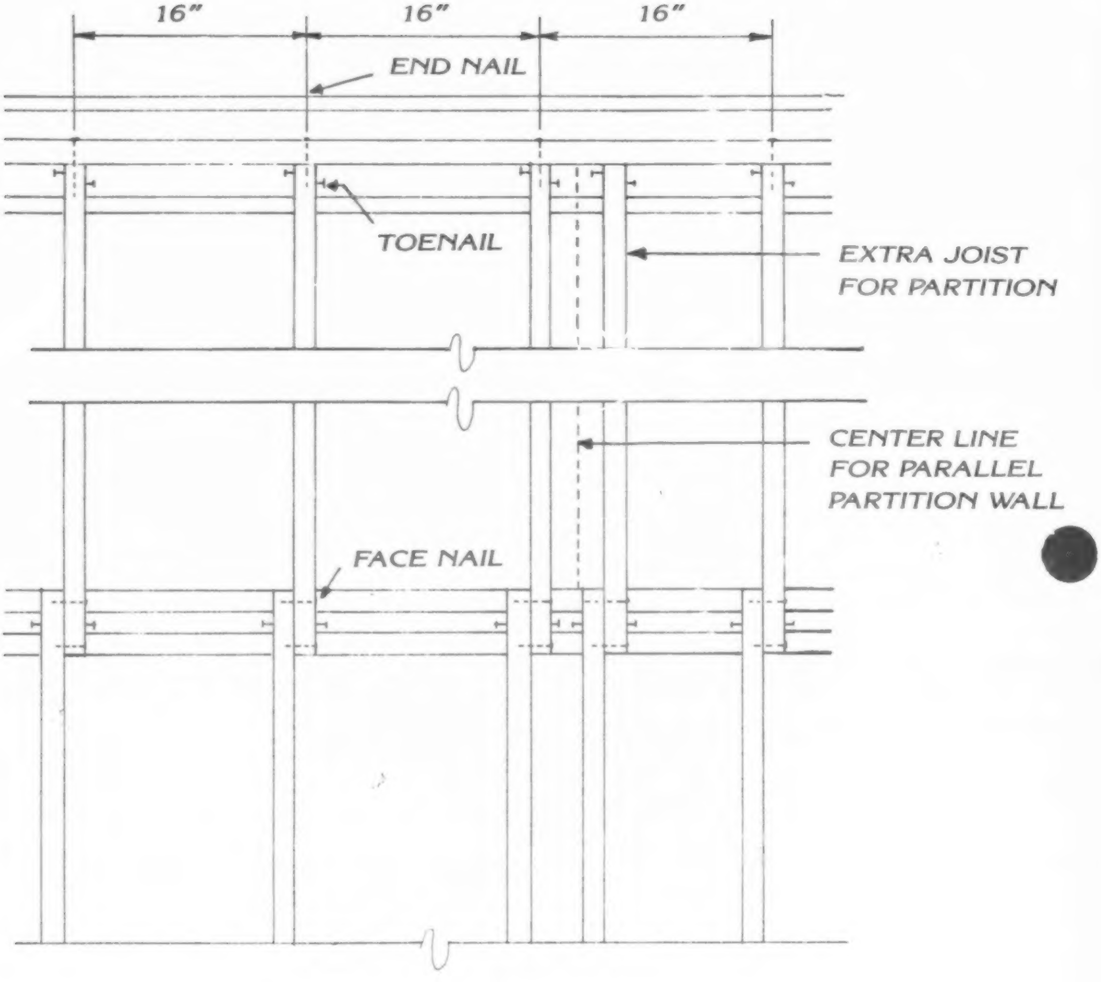

PARTITION
PARALLEL
TO JOISTS
SUBFLOOR
BRIDGING
2×4 BLOCKING
4'-0" O.C.
EXTRA JOIST
JOISTS

P. Place joist centers on positions marked on sill; nail in place (See Figure 15)

1. Nail to header with three 16d box nails
2. Toenail to sill with two 16d box nails
3. Lap joists over beam and toenail to beam
4. Nail joists together

JOB SHEET #1

FIGURE 15

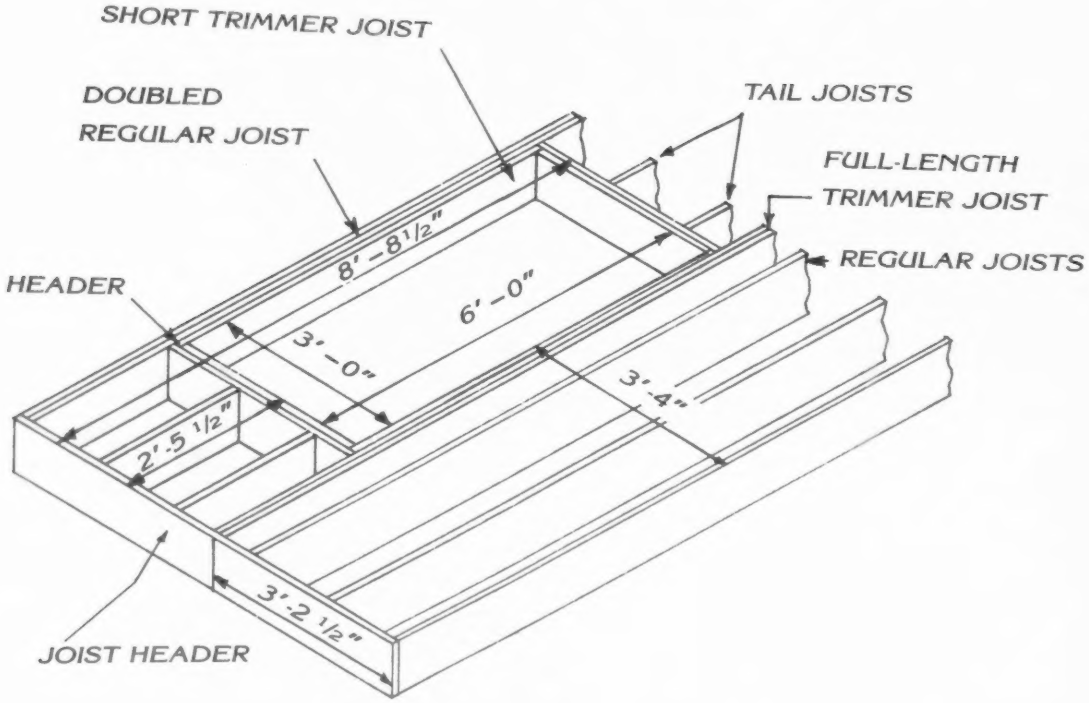

16"
16"
16"
END NAIL
TOENAIL
EXTRA JOIST FOR PARTITION
CENTER LINE FOR PARALLEL PARTITION WALL
FACE NAIL

Q. Frame openings in floor

EXAMPLE: Frame 3'-0" × 6'-0" opening 3'-4" from side of frame and 2'-5 1/2" from end of frame (See Figure 16)

JOB SHEET #1

FIGURE 16


SHORT TRIMMER JOIST
DOUBLED REGULAR JOIST
TAIL JOISTS
FULL-LENGTH TRIMMER JOIST
REGULAR JOISTS
HEADER
8′-8 1/2″
6′-0″
3′-0″
3′-4″
2′-5 1/2″
3′-2 1/2″
JOIST HEADER

1. On side opposite proposed opening, measure in 3′-2½″ along header joist; mark
2. Install full length trimmer joist at this point
3. Cut off fourth and fifth regular joists at 2′-2 ½″ and at 8′-8 ½″ from header joist
4. Cut two header joists to fit snugly between full length trimmer and doubled regular joist
5. Nail headers to tail joists at both ends; nail through trimmer joists and regular joist into headers
6. Cut two short joists 6′-3″ long and nail in place against regular joist and trimmer joist as shown in Figure 16
7. Cut a trimmer joist to full length and nail to first full trimmer, making it a double joist

JOB SHEET #1

8. Cut a regular joist to full length and nail to regular joist on opposite side, making it a double joist

R. Clean up work area and put away tools and materials

FLOOR AND SILL FRAMING
UNIT I

JOB SHEET #2 — INSTALL BRIDGING

I. Tools and materials

   A. Tools

      1. Table saw or radial arm saw
      2. Framing square
      3. Claw hammer
      4. Folding rule or steel tape

   B. Materials for bridging

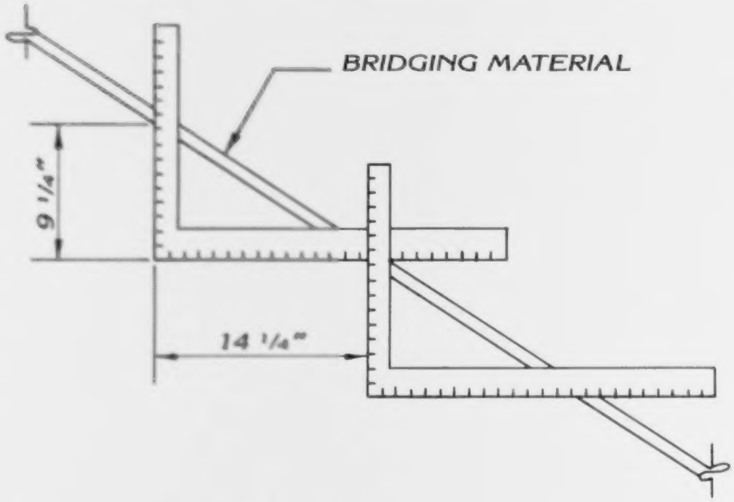
      1. 1×4 lumber "X" bridging
      2. Lumber the same size as the joists for solid bridging
      3. Steel bridging and instructions
      4. 8d box nails

II. Procedure

   A. Wood "X" bridging

      1. Figure number of pieces of wood "X" bridging needed
      2. Use framing square, and lay out bridging as illustrated in Figure 17

FIGURE 17



(NOTE: Due to variation in lumber thickness dimensions, the length may have to be adjusted for actual installation. The layout shown is for 2×10 joists 16" o.c.)

JOB SHEET #2

3. Cut bridging to length

4. Install bridging, nailing only top ends at this time (Figures 18 and 19)

FIGURE 18

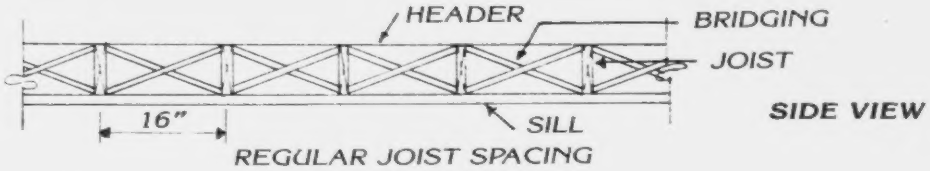
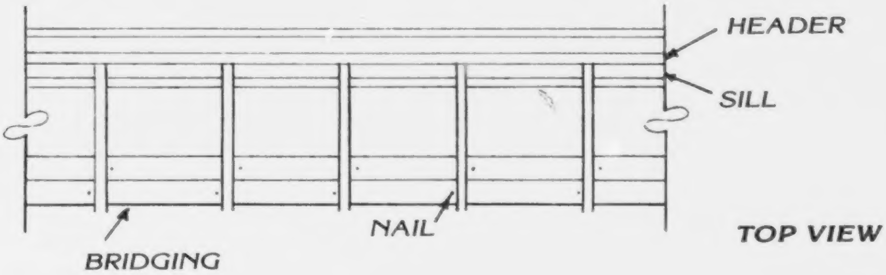

HEADER
BRIDGING
JOIST
SIDE VIEW
16"
SILL
REGULAR JOIST SPACING

FIGURE 19


HEADER
SILL
TOP VIEW
NAIL
BRIDGING

B. Solid lumber bridging

1. Figure number of pieces of solid lumber bridging needed

2. Determine length of bridging

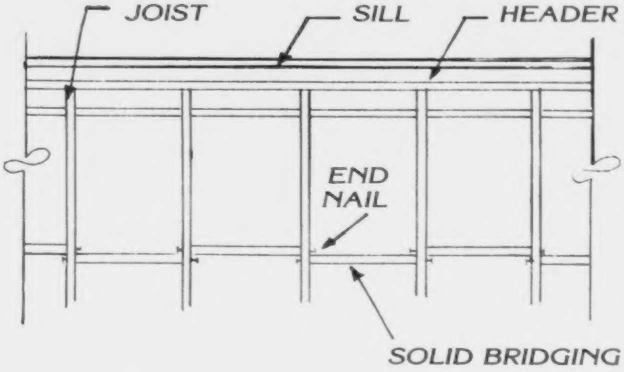
3. Cut bridging 14½ inches long

(NOTE: Due to variations in lumber thickness dimensions, the length may have to be adjusted for actual installation.)

JOB SHEET #2

4. Install bridging in a staggered pattern to facilitate nailing (Figure 20)

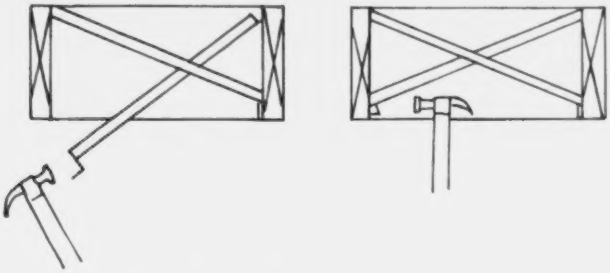
FIGURE 20


JOIST
SILL
HEADER
END NAIL
SOLID BRIDGING

C. Steel "X" bridging

1. Figure number of pieces needed
2. Install bridging, following manufacturer's instructions (Figure 21)

FIGURE 21



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D. Clean up work area and put away tools and materials

FLOOR AND SILL FRAMING
UNIT I

JOB SHEET #3 — LAY DIAGONAL AND RIGHT-ANGLE SUBFLOORS

I. Tools and materials

A. Tools

1. Power handsaw and extension cord
2. Claw hammer
3. Framing square
4. Chalk line
5. Sliding T-bevel
6. Folding rule or steel tape
7. Saber or reciprocating saw to cut holes for pipes if necessary
8. Pencil

B. Materials

1. For diagonal subfloor

   a. Enough 1×6 or 1×8 lumber to cover floor area

   (NOTE: Choose boards that are thoroughly dry. The use of green boards frequently results in squeaks and cracks.)

   b. 8d box nails

2. For right-angle subfloor

   a. Enough 1×6 or 1×8 lumber to cover floor area

   b. Enough 5/8-inch plywood to cover floor area

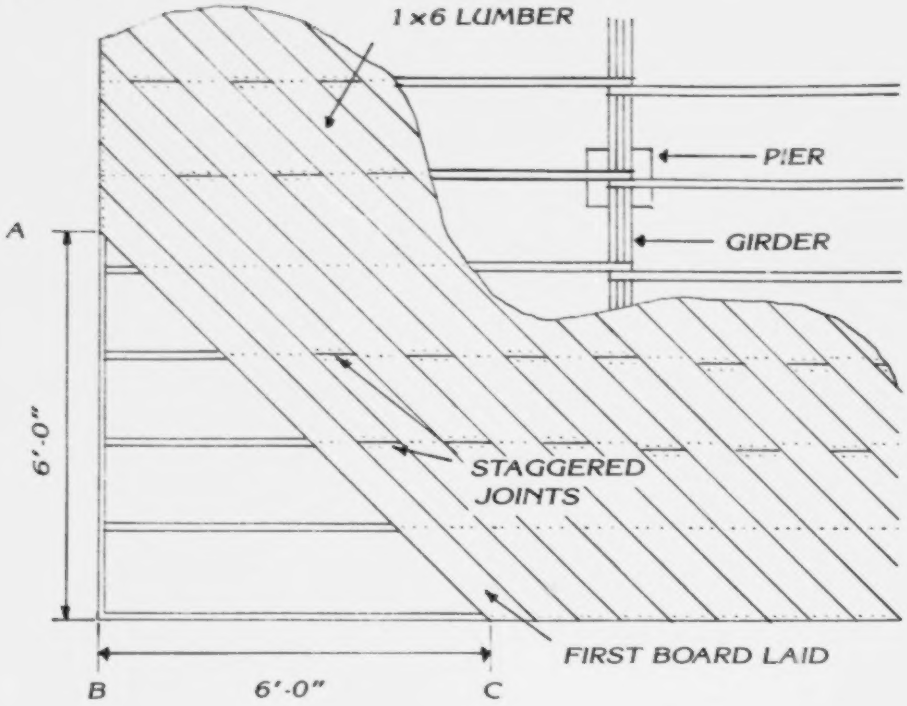
   c. 8d box nails

II. Procedure for installing diagonal subfloor

A. Begin at corner of building and measure equal distances (6 feet) along joist header and along first joist (Points A and C in Figure 22)

JOB SHEET #3

FIGURE 22



(NOTE: For simplification, bridging and other details have been omitted from the drawing.)

B. Snap chalk line along top of joists between these two points to form a 45-degree angle

C. Lay a relatively long board along this line

(NOTE: Generally, the shortest pieces of board should be long enough to span three joists — that is, start at one joist, span another, and be fastened to the third. Of course, shorter pieces will have to be used in the corners.)

D. Use sliding T-bevel to mark board where it will rest on center of joist

E. Cut board to fit

F. Nail board to joist, using three 8d nails per joist, not more than 3/4 inch from edge

(NOTE: Boards must be nailed solidly at each bearing point. Improper or inadequate nailing of the subfloor almost invariably results in squeaky floors. As a rule of thumb, use three 8d box nails per joist for 1×6 and 1×8 lumber.)

JOB SHEET #3

G. Measure other pieces of subfloor boards to make up first diagonal strip, allowing ends of boards to run wild over joist header

H. Cut and nail ends of these pieces so that they butt together at top center of joist, forming a joint

I. Repeat this process to lay remainder of subflooring, spacing boards about ¼ inch apart and staggering all joints as shown in Figure 22

(NOTE: Many carpenters use an 8d nail to space between the edges of the subfloor boards. This spacing allows for drainage and buckling that can occur if the subfloor gets wet during construction. Tongue-and-groove subflooring should have holes drilled at intervals to allow rainwater to run off.)

J. Trim ends that were allowed to run wild over joist header

K. Clean up work area and put away tools and materials

III. Procedure for installing right-angle subfloors

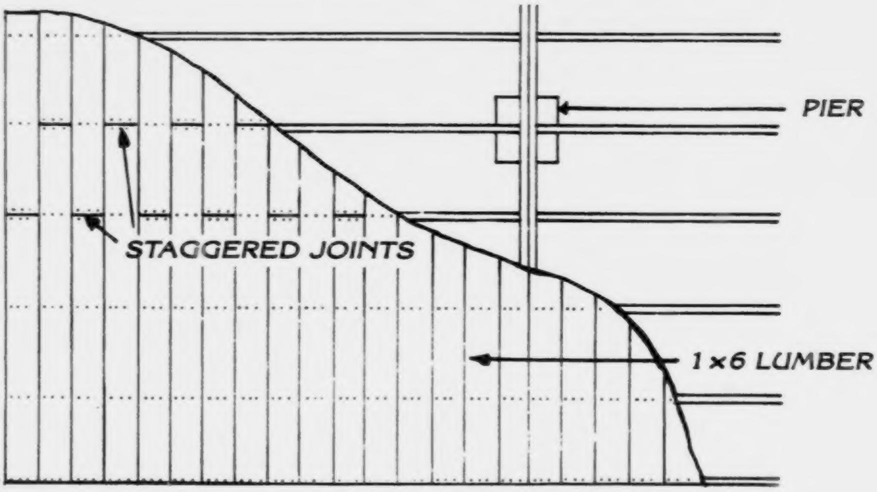
A. Lumber subfloor

(NOTE: When on an actual job, always check the plans to determine the direction the finish floor is to be laid in relation to the direction of the floor joists. If the finish floor is to be laid parallel to the joists, a straight or right-angle lumber subfloor may be laid.)

1. Start at corner from which joist was laid off and lay first board at right angle to joists
2. Mark board where it will rest on center of joist; cut to fit
3. Nail board to joist, using three 8d box nails per joist, not more than ¾ inch from edge
4. Measure, cut, and nail other pieces of subfloor boards to make up first right-angle strip
5. Cut and nail ends of these pieces so that they butt together at center of joist, forming a joint
6. Repeat this process to lay remainder of subflooring, spacing boards about ¼ inch apart and staggering all joints as shown in Figure 23

JOB SHEET #3

FIGURE 23



7. Clean up work area and put away tools and materials

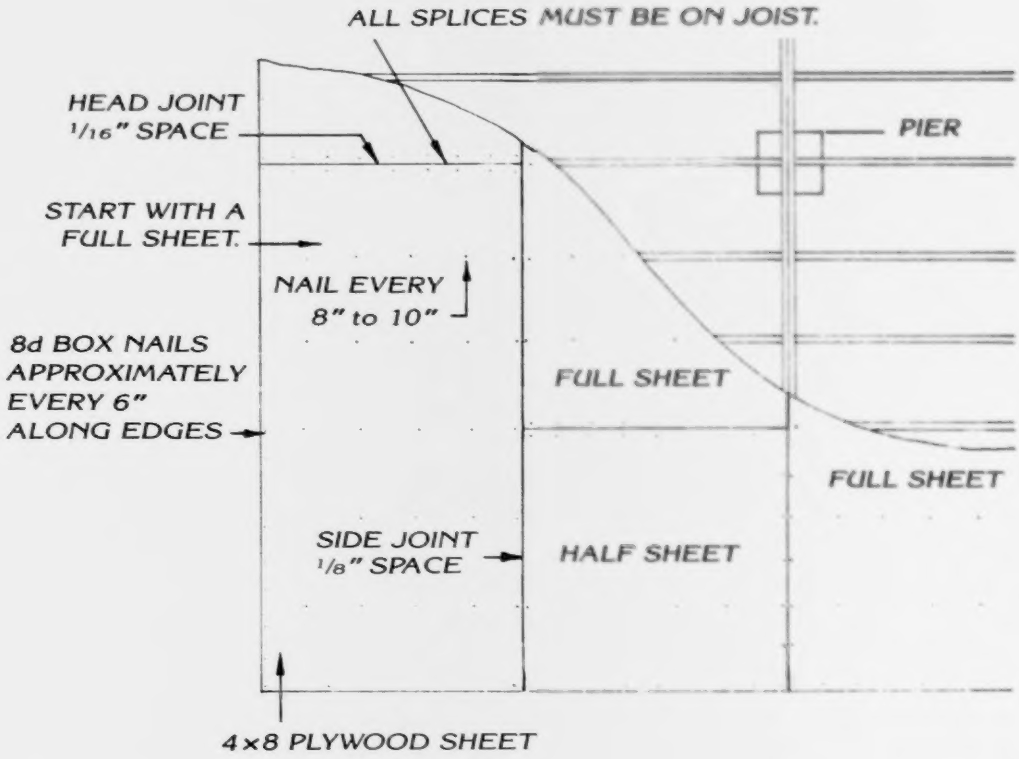
B. Plywood subfloor

(NOTE: Check local building requirements for nail spacing.)

1. Begin by placing a full sheet of plywood even with one of the outside corners of the joist framing, making sure that the grain of the plywood runs at right angles to the joists (See Figure 24)

JOB SHEET #3

FIGURE 24


ALL SPLICES MUST BE ON JOIST.
HEAD JOINT 1/16" SPACE
PIER
START WITH A FULL SHEET.
NAIL EVERY 8" to 10"
8d BOX NAILS APPROXIMATELY EVERY 6" ALONG EDGES
FULL SHEET
FULL SHEET
SIDE JOINT 1/8" SPACE
HALF SHEET
4×8 PLYWOOD SHEET

2. Make sure that all edges rest on centers of joists

3. Drive just enough nails to hold the plywood in place

4. Place next full sheet in position at end of first sheet; be sure that joint is centered over joist, and leave about 1/16-inch space between the panels at the head joint

5. Begin the second row of sheets next to the first panel laid

    a. Cut a panel in half

    b. Lay end of half panel flush with outside of building, leaving about 1/8 inch of space at side joint

    c. Nail half panel to joists

JOB SHEET #3

(NOTE: If the joists are running at right angles to the grain direction, measure and cut the panel so that the joint will be on the fourth joist.)

6. Continue to lay and nail panels in the second row
7. Start the third row of panels with a full sheet; this will stagger the joints and provide the strongest floor
8. Continue to lay the subfloor, driving just enough nails in each panel to hold it in position, until all panels are laid
9. Nail all panels as per local building codes
10. Clean up work area and put away tools and materials

FLOOR AND SILL FRAMING
UNIT I

JOB SHEET #4 — INSTALL JOISTS FOR A CANTILEVER FLOOR

I. Tools and materials

A. Tools

1. Power handsaw and extension cord
2. Claw hammer
3. Framing square
4. Level
5. Folding rule or steel tape
6. One-hundred-foot tape

B. Materials

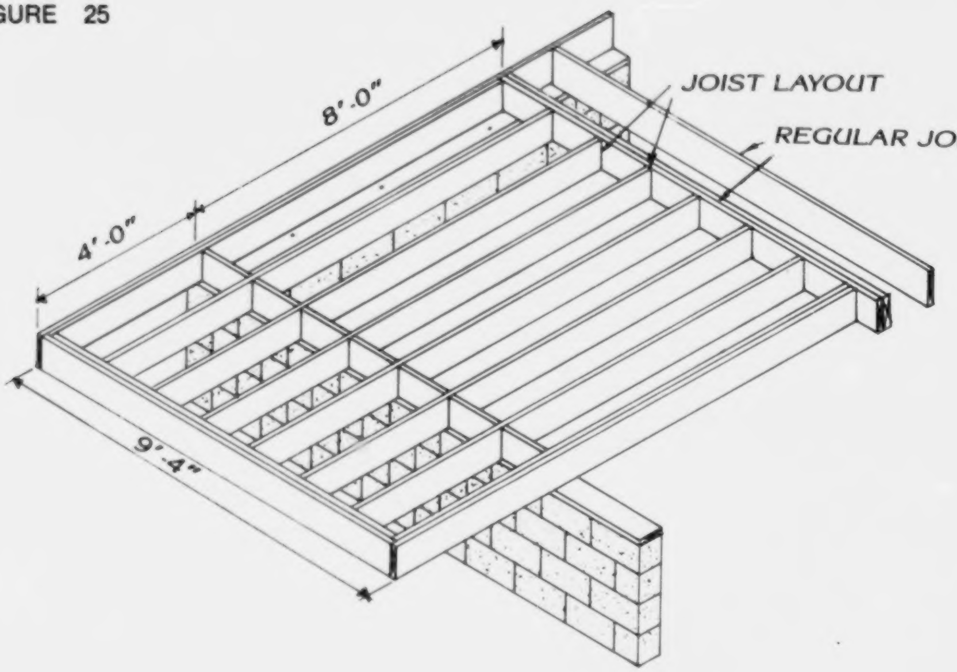
1. 2×10s for joists and headers
2. 8d box nails
3. 16d box nails

II. Procedure for parallel floor joists

(NOTE: The framing procedure for parallel floor joists is comparatively simple. All you do is use longer floor joists and extend them out the length of the projection, keeping in mind that the joist should extend inward a distance equal to at least twice the overhang. See Figure 25.)

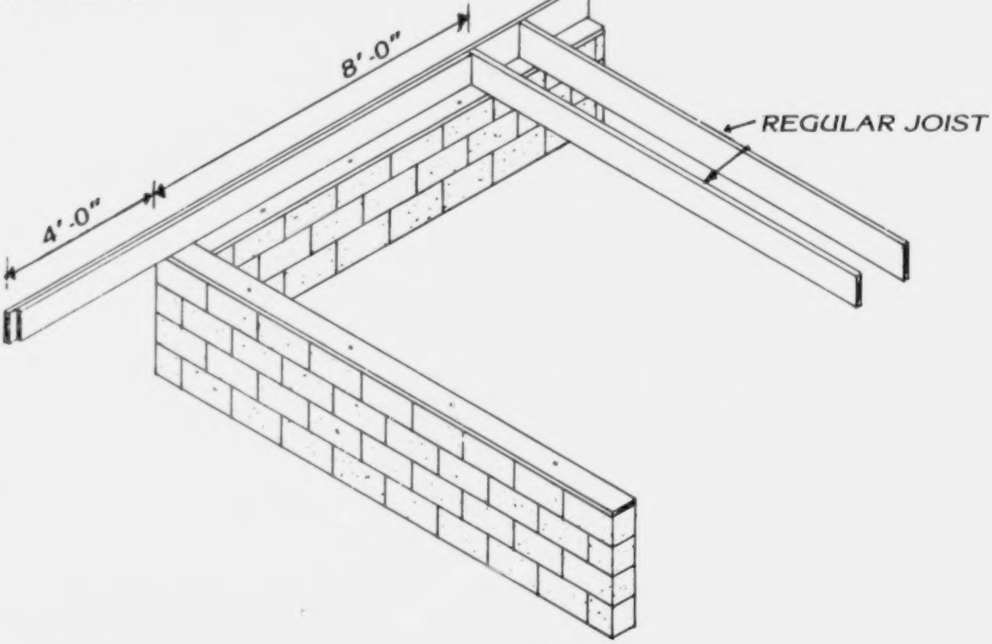
JOB SHEET #4

FIGURE 25


8'-0"
4'-0"
9'-4"
JOIST LAYOUT
REGULAR JOIST

A. Begin by doubling the first joist (Figure 26)

FIGURE 26


8'-0"
4'-0"
REGULAR JOIST

JOB SHEET #4

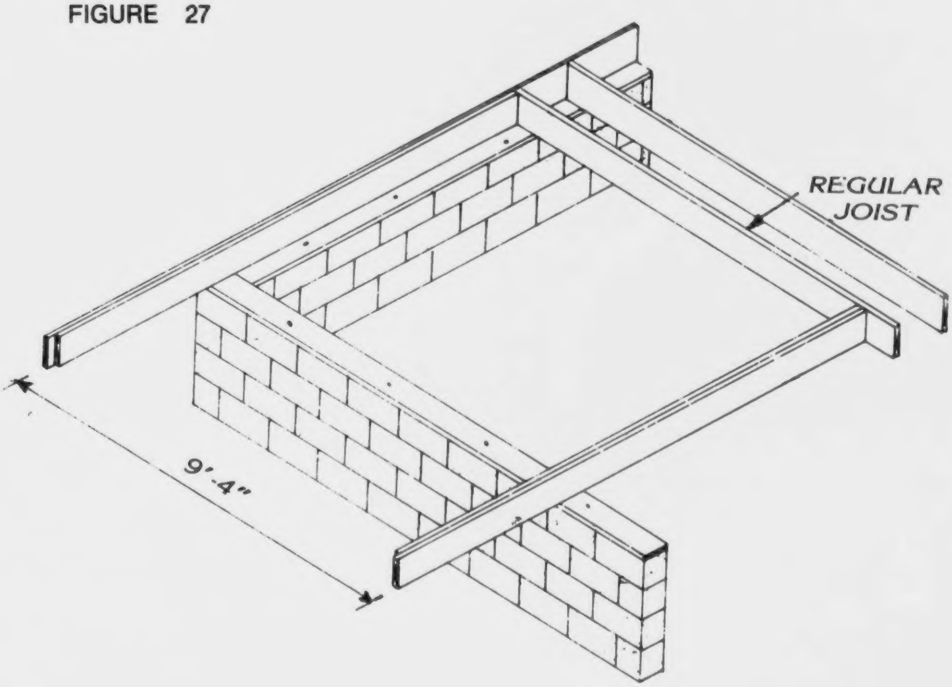
B. Measure, cut, and nail in double joist on opposite end

(NOTE: It may be necessary to notch top of all cantilever joists so that deck will be slightly lower than the door sill.)

1. Measure across header and mark end joist location at opposite end; also mark same location on plate
2. Measure and cut two joists for double joist

   (NOTE: Inside joist will be 1½ inches shorter to receive header. Nail these together before installing.)
3. Nail double joist in place at marked location (Figure 27)

FIGURE 27



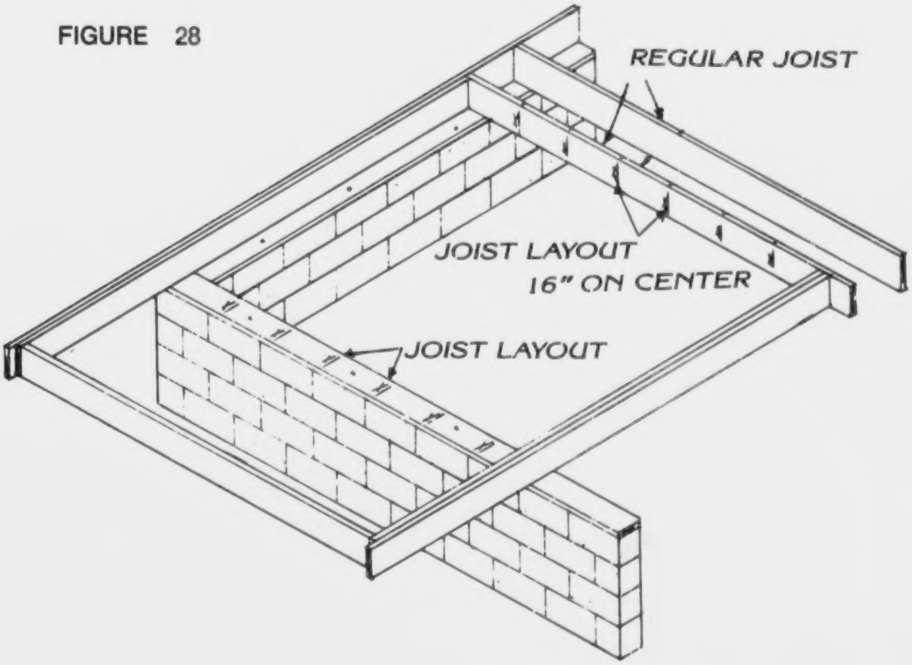
C. Lay out joists 16 inches on center at both sill and header

D. Measure and cut header to fit between the two short members in the double joist

E. Nail in header (See Figure 28)

JOB SHEET #4

FIGURE 28

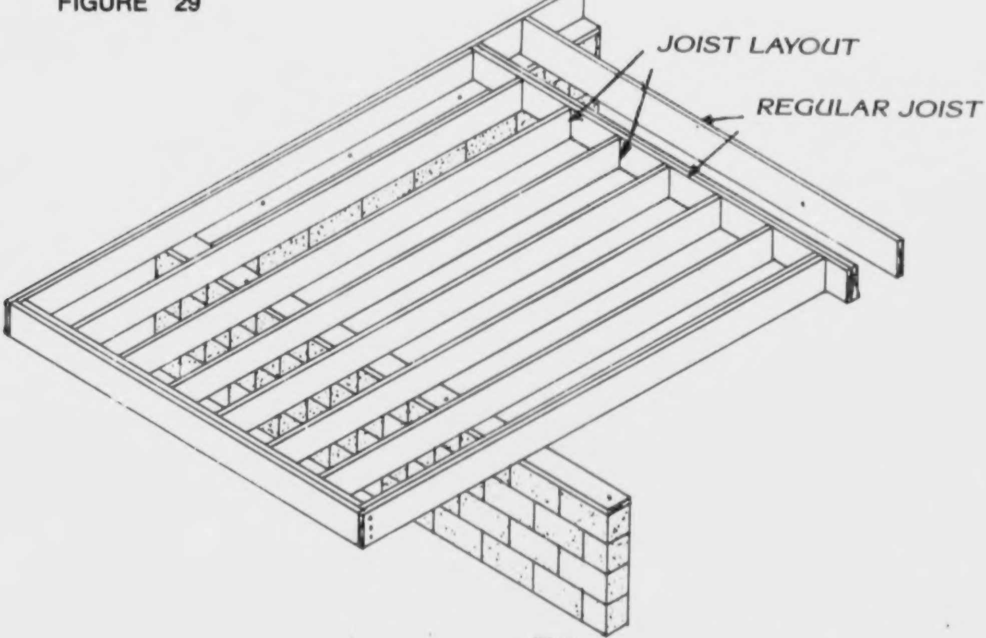

REGULAR JOIST
JOIST LAYOUT
16" ON CENTER
JOIST LAYOUT

F. Measure, cut, and then nail in remainder of joists

(NOTE: Joists, spacing, and size depend on size of deck and provide for carrying the live loads.)

G. Measure, cut, and nail in double header on both ends (See Figure 29)

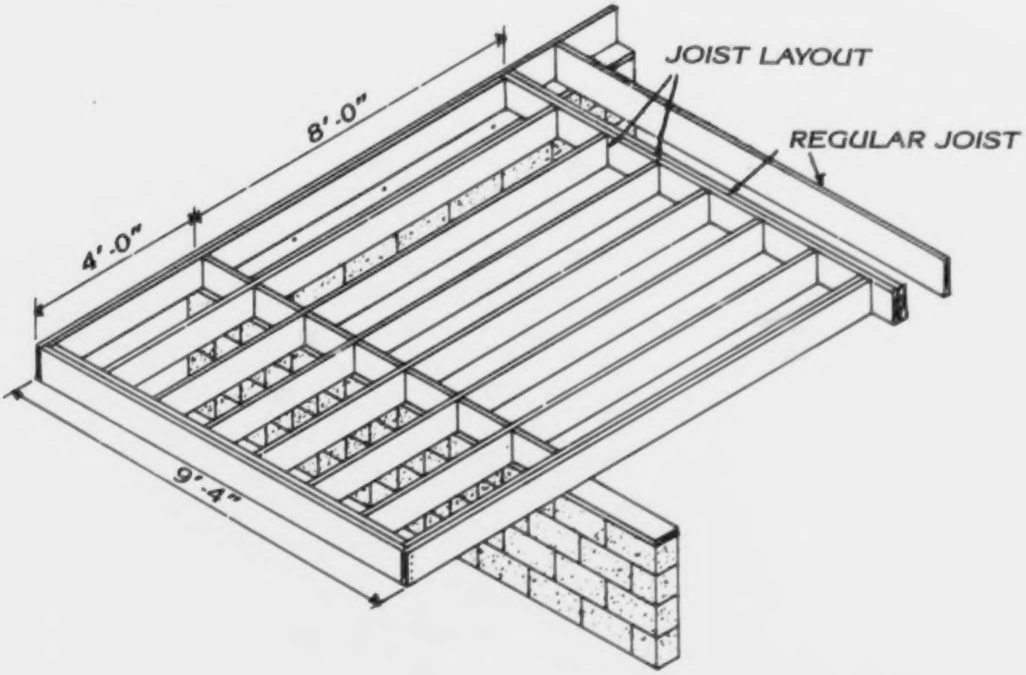
FIGURE 29


JOIST LAYOUT
REGULAR JOIST

JOB SHEET #4

H. Use solid blocking to block between joists at building line (Figure 30)

FIGURE 30


JOIST LAYOUT
REGULAR JOIST
8'-0"
4'-0"
9'-4"

I. Clean up work area and put away tools and materials

FLOOR AND SILL FRAMING
UNIT I

TEST

NAME ____ SCORE ________________

1. Match to their correct definitions terms associated with floor and sill framing. Write the correct numbers in the blanks.

_____a. Sheet metal placed on foundation wall under sill to prevent passage of termites into structure

_____b. One of a series of parallel framing members used to support floor and ceiling loads and supported, in turn, by beams or girders

_____c. Distance between structural supports such as walls, columns, piers, beams, or girders

_____d. Framing member into which common joists are fitted forming the box sill; also used to support free ends of joist when framing openings in floor

_____e. Bolt embedded in foundation; used to secure sill to foundation

_____f. High side of curve on edge of framing lumber

_____g. Lowest member of structure's frame; rests horizontally on foundation and supports floor joists

_____h. Supporting portion of a structure below the first floor construction, including the footings

_____i. Wood or metal pieces fitted in pairs from bottom of one floor joist to top of adjacent joists, and crossed to distribute floor load; solid stock of same size material as joists may be used

_____j. Boards or panels laid directly on floor joists and over which finish floor is laid

_____k. Any large horizontal piece of timber, precast concrete, iron, or other material used to support concentrated loads at particular points along its length

_____l. Resilient, waterproof material used under sill as a seal against air, dirt, and insects

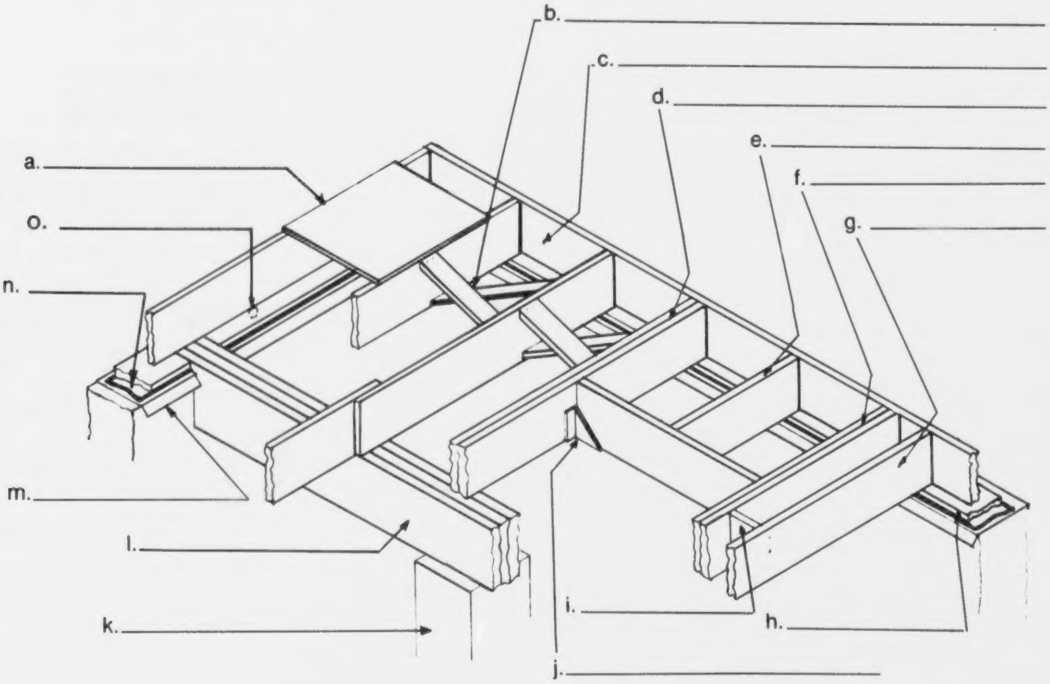
_____m. Metal stirrup secured to face of structural member to support and align ends of joist flush with member

1. Joist header
2. Foundation
3. Sill sealer
4. Crown
5. Joist hanger
6. Bridging
7. Span
8. Beam or girder
9. Termite shield
10. Sill
11. Anchor bolt
12. Subfloor
13. Joist

TEST

2. Identify floor and sill framing and support members illustrated below. Write the correct names in the blanks.

Anchor bolt
Wood "X" bridging
Termite shield
Double joist
Joist header
Beam or girder
Tail joist
Joist hanger
Solid bridging
Trimmer joist
Common joist
Sill
Pier
Subfloor
Sill Sealer



3. Name three methods used to fasten sills to the foundation.

a. ____________________

b. ____________________

c. ____________________

TEST

4. Select from the following list types of girders. Write an "X" in the blank before each correct type.

   ______a. Steel beam

   ______b. Partition wall

   ______c. Precast concrete

   ______d. Solid timber

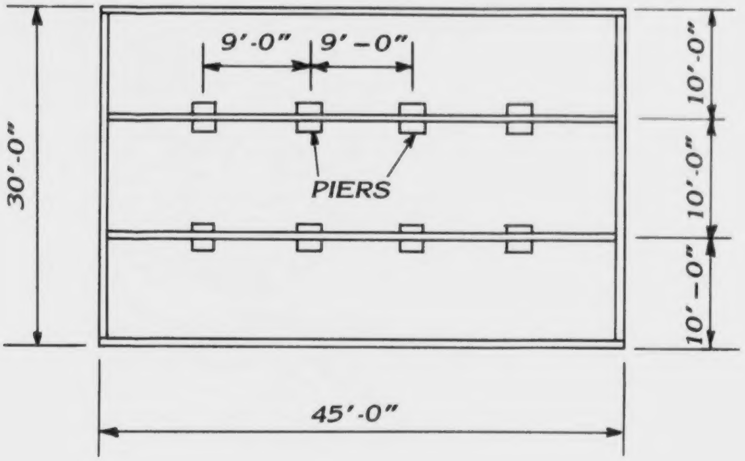
   ______e. 2 × 4 doubled

   ______f. Built-up timber

5. Determine proper girder size for safe use. Use the chart provided to figure the correct girder size if a built-up girder is to be in the following plan. The plan is for a first floor with a live load of 40 pounds per square foot and a dead load of 10 pounds per square foot.

Safe Girder Loads

Nominal girder size	Safe load in pounds for spans shown				
	6 Ft.	7 Ft.	8 Ft.	9 Ft.	10 Ft.
6 × 8 Solid	8,306	7,118	6,220	5,539	4,583
6 × 8 Built up	7,359	6,306	5,511	4,908	4,062
6 × 10 Solid	11,357	10,804	9,980	8,887	7,997
6 × 10 Built up	10,068	9,576	8,844	7,878	7,086
8 × 8 Solid	11,326	9,706	8,482	7,553	6,250
8 × 8 Built up	9,812	8,408	7,348	6,544	5,416
8 × 10 Solid	15,487	14,732	13,608	12,116	10,902
8 × 10 Built up	13,424	12,968	11,792	10,504	9,448



Size of built-up girder ______________________________

TEST

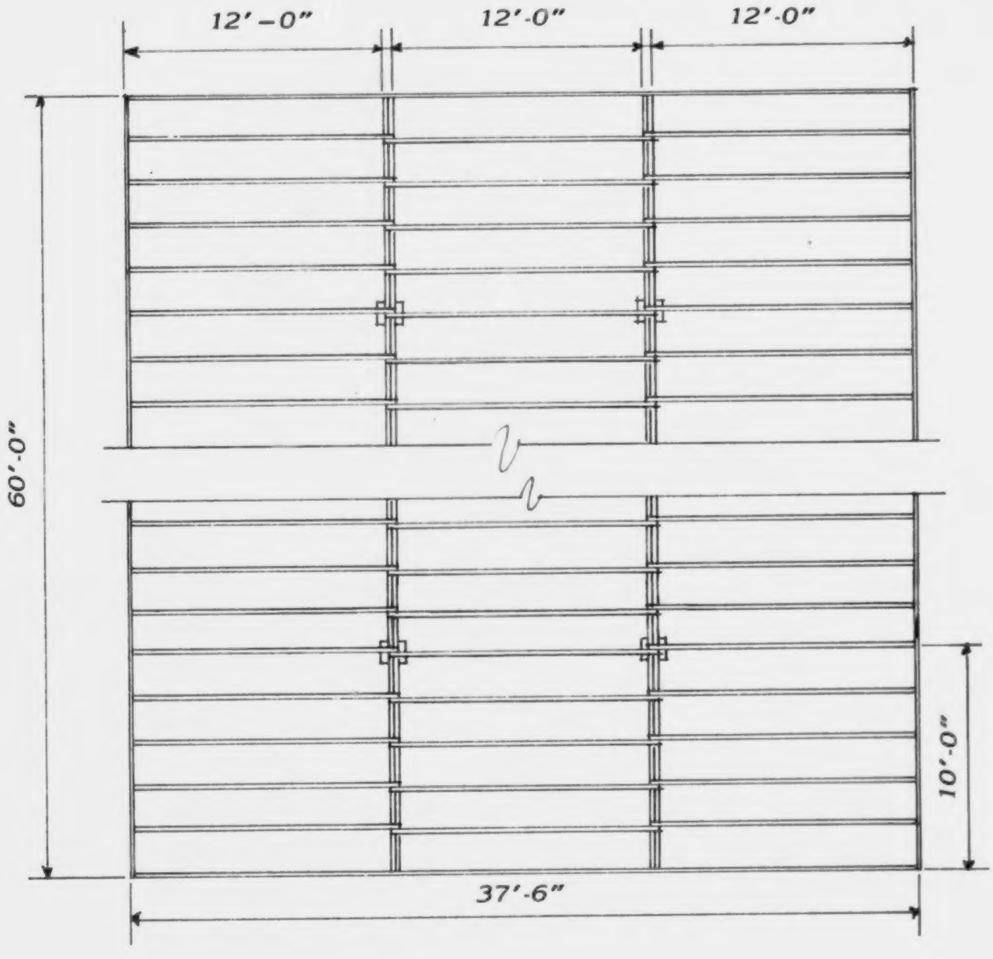
6. List three types of joists.

a. ____

b. ____

c. ____

7. Determine proper joist size for ordinary load conditions in the illustration below. This construction will have plastered ceilings and a live load of 40 pounds per square foot. Use the table on the next page.



Size of joist ____

TEST

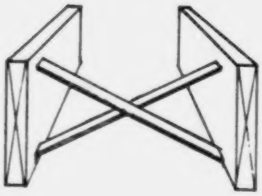
Safe Joist Spans

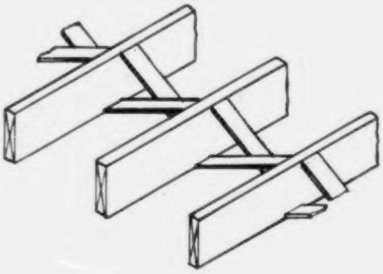
Spans for live loads shown

Nominal	30#	40#	50#	60#	70#
Joist Size	Spacing	Live load	Live load	Live load	Live load
2×6	12″	14′-10″	13′-2″	12′-0″	11′-1″
	16″	12′-11″	11′-6″	10′-5″	9′-8″
	24″	10′-8″	9′-6″	8′-7″	7′-10″
2×8	12″	19′-7″	17′-5″	15′-10″	14′-8″
	16″	17′-1″	15′-3″	13′-10″	12′-9″
	24″	14′-2″	12′-6″	11′-4″	10′-6″
2×10	12″	24′-6″	21′-10″	19′-11″	18′-5″
	16″	21′-6″	19′-2″	17′-5″	16′-1″
	24″	17′-10″	15′-10″	14′-4″	13′-3″
2×12	12″	29′-4″	26′-3″	24′-0″	22′-2″
	16″	25′-10″	23′-0″	21′-0″	19′-5″
	24″	21′-5″	19′-1″	17′-4″	16′-0″
3×8	12″	24′-3″	21′-8″	19′-10″	18′-4″
	16″	21′-4″	19′-1″	17′-4″	16′-0″
	24″	17′-9″	15′-9″	14′-4″	13′-3″
3×10	12″	30′-2″	27′-1″	34′-10″	23′-0″
	16″	26′-8″	23′-10″	21′-9″	20′-2″
	24″	22′-3″	19′-10″	18′-1″	16′-8″

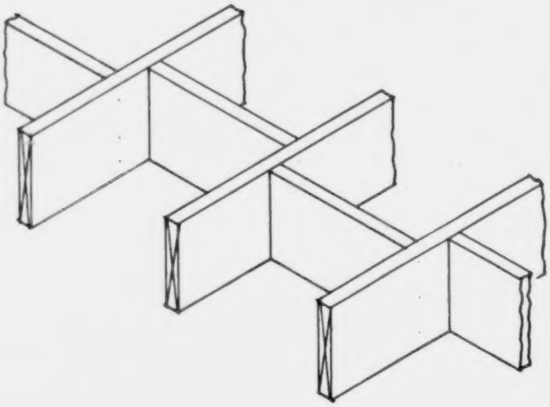
TEST

8. Identify the types of bridging illustrated below. Write the correct names in the blanks.





a. ______________________________ b. ______________________________



c. ______________________________

9. List four types of subflooring materials.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

TEST

10. Discuss functional designs used to lay subflooring. Describe the design, state the type of subflooring for which the design is suitable, and list at least one advantage or disadvantage compared to the other design.

a. ____

____

____

b. ____

____

____

11. List three purposes of subflooring.

a. ____

____

b. ____

____

c. ____

____

12. Match fasteners used in floor framing to their correct uses. Write the correct numbers in the blanks.

_____a. Furnished to attach joist hangers

_____b. Used to install subflooring, sheathing, wall paneling, and siding

_____c. Used to install wood "X" bridging and subfloor

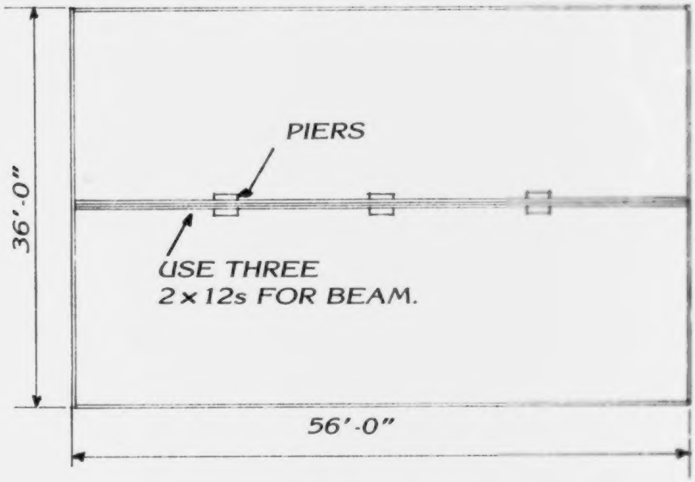
_____d. Used to attach header to joist, to install solid bridging, and to construct beams and girders

_____e. Used to apply subfloor

1. Special nails
2. 16d box nails
3. Construction glue or adhesive
4. 8d box nails
5. Pneumatic, ring-shank, and screw nails

TEST

13. Estimate amount of material needed to frame a floor and sill and to lay a subfloor for the structure illustrated below.



a. Sill sealer ______________________________

b. Termite shield ______________________________

c. Sill (2×6s) ______________________________

d. Beams (2×12s) ______________________________

e. Joists (2×8s, 12" on center) ______________________________

f. Joist headers (2×8s) ______________________________

g. Bridging (solid lumber) ______________________________

h. Subflooring (plywood) ______________________________

(NOTE: Test question 14 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

14. Demonstrate the ability to

a. Build a box sill, install floor joists, and frame an opening.

b. Install bridging.

c. Lay diagonal and right-angle subfloors.

d. Install joists for a cantilever floor.

FLOOR AND SILL FRAMING
UNIT I

ANSWERS TO TEST

1. a. 9
   b. 13
   c. 7
   d. 1
   e. 11
   f. 4
   g. 10
   h. 2
   i. 6
   j. 12
   k. 8
   l. 3
   m. 5

2. a. Subfloor
   b. Wood "X" bridging
   c. Joist header
   d. Double joist
   e. Tail joist
   f. Trimmer joist
   g. Common joist
   h. Sill
   i. Solid bridging
   j. Joist hanger
   k. Pier
   l. Beam or girder
   m. Termite shield
   n. Sill sealer
   o. Anchor bolt

3. a. Anchor bolts
   b. Powder-actuated pins
   c. Metal plates or straps

4. a, c, d, f

5. 6×8 built-up girder

6. Answer should include any three of the following
   a. Solid wood
   b. Fabricated wood
   c. Steel bar
   d. Steel "C"
   e. Reinforced concrete

7. Size of joist - 2×8

8. a. Steel
   b. Wood "X" bridging
   c. Solid bridging

9. Answer should include any four of the following
   a. Shiplap lumber
   b. Tongue-and-groove lumber
   c. Common lumber

ANSWERS TO TEST

d. Plywood
e. Fiber board
f. Wafer board
g. Strand board
h. Particle board

10. a. Discussion should include
    Subflooring laid diagonally to joists may be used to lay shiplap, tongue-and-groove, or common lumber
    Answer should also include at least one of the following
    1) Permits finish floor to be laid in any direction
    2) Provides better than average bracing and stiffness to building
    3) Is preferred in homes of two or more stories
    b. Discussion should include
    Subflooring laid at right angles to joists may be used to lay any of the subfloor materials
    Answer should also include at least one of the following
    1) Requires that finish floor run parallel to joists (be laid at right angle to subfloor)
    2) Provides average bracing and stiffness to building
    3) Generally results in less waste than diagonal subfloors
    4) Requires less labor time to install than diagonal subfloors

11. Answer should include any three of the following
    a. Lending bracing strength to building
    b. Providing solid base for finish floor, thus making floor sag and squeaks less likely
    c. Acting as barrier to cold and dampness, thus keeping building warmer and drier in winter
    d. Providing a safe working surface for constructing the building

12. a. 1
    b. 3
    c. 4
    d. 2
    e. 5

13. a. 184 lineal feet
    b. 184 lineal feet
    c. 184 lineal feet
    d. 168 lineal feet of 2×12s or one 2×12 beam 56 feet long
    e. 114 joists - 20′ long
    f. 112 lineal feet
    g. 224 lineal feet 2×8s
    h. 63 pieces

14. Performance skills evaluated to the satisfaction of the instructor.

WALL AND CEILING FRAMING
UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to identify wall and partition members, estimate materials, and frame a single-story structure. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with wall and ceiling framing to their correct definitions.
2. Identify framing members used in wall and partition framing.
3. Complete drawings of common methods used to construct outside corners of wall frames.
4. Complete drawings of common methods used to construct partition Ts.
5. Label types of headers.
6. Compute the length of a regular stud.
7. Compute rough opening (R.O.) dimensions for windows.
8. Compute rough opening (R.O.) dimensions for doors.
9. Compute the length of trimmers for window and door openings.
10. Compute the length of headers for rough openings.
11. Select from a list construction details that should be added during wall framing.
12. List methods used to brace walls.
13. Select from a list pennyweights of nails most often used in framing.
14. Select from a list considerations to be made before selecting joist size and spacing.
15. Match ceiling joist size to allowable spans.
16. List methods used to support ceiling joists.
17. List methods used to anchor joists to partition walls.

OBJECTIVE SHEET

18. Estimate materials for ceiling joists.
19. Describe methods used to protect joists from twist or bow.
20. List types of finishes used on ceilings.
21. Estimate amount of materials for wall and partition framing.
22. Demonstrate the ability to
    a. Lay out wall and partition locations on floor.
    b. Cut studs, trimmers, cripples, and headers to length.
    c. Build corners, Ts, and headers.
    d. Construct wall sections for a single-story structure.
    e. Lay out and install ceiling joists.

WALL AND CEILING FRAMING
UNIT II

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Transparency masters
  1. TM #1 — Wall and Partition Framing Members
  2. TM #2 — Stud Length for a Slab Floor
  3. TM #3 — Stud Length for a Wood Floor
  4. TM #4 — Door and Window Headers
  5. TM #5 — Trimmer Studs
  6. TM #6 — Temporary Bracing
  7. TM #7 — Nails
  8. TM #8 — Lengths of Nails by Pennyweights
- D. Supplements
  1. Supplement #1 — Suggestions to Speed Up Ceiling Joist Installation
  2. Supplement #2 — Ceiling Joist Spacing and Allowable Spans
- E. Information sheet
- F. Assignment sheets
  1. Assignment Sheet #1 — Calculate Rough Opening Dimensions for Windows
  2. Assignment Sheet #2 — Estimate Materials for Ceiling Joists
  3. Assignment Sheet #3 — Estimate Materials for Wall and Partition Framing
- G. Answers to assignment sheets
- H. Job sheets
  1. Job Sheet #1 — Lay Out Wall and Partition Locations on Floor
  2. Job Sheet #2 — Cut Studs, Trimmers, Cripples, and Headers to Length
  3. Job Sheet #3 — Build Corners, Ts, and Headers

SUGGESTED ACTIVITIES

   4. Job Sheet #4 — Construct Wall Sections for a Single-Story Structure

   5. Job Sheet #5 — Lay Out and Install Ceiling Joists

  I. Test

  J. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain materials necessary to supplement unit.

   1. Order transparencies and competency profiles.

   (NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W., Washington, DC 20006, phone 202-393-2040.)

   2. Order film *The Wood Shell.* Color, 30 minutes, 1982; Circle Oak Productions, 73 Girdle Ridge Drive, Katonah, New York 10536, telephone 914-232-9451.

   This film finishes the house that *The Foundation* started, and includes the building of walls, floors, ceilings, and roof.

   (NOTE: This film is available only to Oklahoma teachers on a free-loan basis from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074. Out-of-state teachers must order from the address listed with the film.)

  C. Introduce unit.

  SUGGESTIONS:

  - Tour construction sites where frames have been erected; point out the planning behind the construction sequence and safety considerations such as bracing.
  - Have students discuss the construction process and the steps involved in framing to gain some insight into the complexity of the task and the need for careful planning.
  - Show students the film *The Wood Shell.*

  D. Provide students with objective sheet.

  E. Discuss unit and specific objectives, relating them to previous units and your introduction to this unit.

SUGGESTED ACTIVITIES

F. Provide students with information sheet.

G. Discuss information sheet.

1. Use Information Sheet, Section I to discuss terms associated with wall framing.

   SUGGESTIONS:

   - Use transparencies, an actual construction site, a model, or building plans to illustrate appropriate parts.
   - Provide students with door and window framing instructions that emphasize rough openings.

2. Use Information Sheet, Section II and Transparency #1 to discuss framing members.

   SUGGESTIONS:

   - Relate framing members to terms and definitions.
   - Use a model or a full-size wall to illustrate the parts, emphasizing how parts fit together to provide the required strength.

3. Use Information Sheet, Sections III and IV to discuss corner and partition T assemblies.

   SUGGESTIONS:

   - Construct a model of each type of assembly.
   - Discuss advantages and disadvantages of each type.
   - Discuss other types of assemblies.

4. Use Information Sheet, Section V and Transparency #4 to discuss types of headers.

   SUGGESTIONS:

   - Demonstrate the construction of each type of header.
   - Acquaint the students with the use of header schedules and header span charts.

5. Use Information Sheet, Section VI and Transparencies #2 and #3 to discuss computing the lengths of studs.

   SUGGESTIONS:

   - Demonstrate the calculation steps and translate them into the actual cutting and construction of stud framing.

SUGGESTED ACTIVITIES

- Give the students problems with different finished ceiling heights and flooring to allow them to practice calculating stud lengths.

6. Use Information Sheet, Sections VII and VIII to discuss calculating rough opening sizes.

   SUGGESTIONS:

   - Show students how to determine finish opening height from plans.
   - Provide students with literature from window and door manufacturers to study rough opening specifications.
   - Build a rough opening to calculations and use shims to demonstrate what problems would be experienced if the rough opening were made too small.
   - Discuss other types of rough openings, such as those for patio doors, bifold doors, pocket doors, bay windows, fireplaces, etc.
   - Use Assignment Sheet #1 to allow students to practice calculating rough openings.

7. Use Information Sheet, Section IX and Transparency #5 to discuss computing trimmer lengths, relating the information to headers and rough openings.

8. Use Information Sheet, Section X to discuss header lengths.

   SUGGESTIONS:

   - Relate header length to rough opening size and the use of trimmers.
   - Emphasize the use of span charts and header schedules, giving the students problems to figure.

9. Use Information Sheet, Section XI to discuss framing details to consider during wall framing.

   SUGGESTIONS:

   - Invite a framing carpenter to talk to the class about how frame construction must coordinate with the other types of construction involved in a job.
   - Provide students with construction plans and ask them to identify details that require special consideration on the part of framers; discuss these requirements with the class.

SUGGESTED ACTIVITIES

10. Use Information Sheet, Section XII and Transparency #6 to discuss wall bracing.

    SUGGESTIONS:

    - Push an unbraced wall over to show the need for temporary bracing.
    - Demonstrate the use of each type of permanent and temporary bracing.
    - Demonstrate the use of gauge blocks in setting a straight wall.

11. Use Information Sheet, Section XIII and Transparencies #7 and #8 to discuss nails.

    SUGGESTIONS:

    - Provide students with copies of transparency masters.
    - Show students various sizes and types of nails; discuss their specific applications.
    - Demonstrate toenailing and other techniques.
    - Demonstrate pneumatic nailers and explain their use in framing.

12. Use Information Sheet, Sections XIV and XV to discuss considerations to be made before selecting joist size and spacing.

    SUGGESTIONS:

    - Provide students with Supplements #1 and #2 and discuss installation of ceiling joists.
    - Provide students with plans where various considerations must be taken into account.
    - Review floor joist span discussion from the previous unit and relate it to ceiling joists, emphasizing loads and lumber grades.

13. Use Information Sheet, Sections XVI and XVII to discuss methods of supporting and anchoring ceiling joists.

    SUGGESTIONS:

    - Explain why one method may be chosen over another in specific applications.
    - Provide models of each method.

SUGGESTED ACTIVITIES

14. Use Information Sheet, Section XVIII to discuss estimating material for ceiling joist

    SUGGESTIONS:

    - Use a drawing or transparency to explain how the multiplying constants were determined.
    - Provide students with plans and allow them to practice estimating materials.
    - Have students contact material suppliers to determine costs and availability of various grades, species, and lengths of joist material.

15. Use Information Sheet, Section XIX to discuss methods used to protect joists from twist or bow.

    SUGGESTIONS:

    - Explain the damage that can result from deformed ceiling joists and the problems caused in finish application; provide pictures if available.
    - Demonstrate each method.

16. Use Information Sheet, Section XX to discuss types of ceiling finishes, emphasizing the framing considerations required for each.

    (NOTE: Actual installation of several of these finishes will be covered in later units.)

    SUGGESTIONS:

    - Have installers of the various finishes discuss their procedures and framing allowances that should be made.
    - Discuss advantages and disadvantages of each type of finish, especially in terms of framing requirements.

17. Use Information Sheet, Section XXI to discuss material estimating.

    SUGGESTIONS:

    - Invite a building materials supplier to discuss types, dimensions, grades, and costs of wood used in wall and partition framing.
    - Use Assignment Sheet #2 to allow students practice in estimating materials.
    - Provide students with additional practice by allowing them to estimate materials from other sets of plans; allow students to order material whenever possible.

SUGGESTED ACTIVITIES

    - Emphasize the importance and cost savings of planning the cutting of material, with consideration given to trimmers, cripple studs, and blocking.

H. Provide students with job sheets.

I. Demonstate job sheet procedures and allow students to practice.

(NOTE: The procedure for laying out and installing ceiling joists has been included in this unit because this is the usual sequence in construction. However, you may want to cover part of the roof framing unit to help students understand the influence of roof design on joist layout.)

SUGGESTIONS:

- Try to get the students to plan the procedures and to visualize the construction process.
- Tour construction sites and allow students to watch framers at work.
- Review power tool safety and care and other safety information applicable to framing.

J. Review unit.

K. Give test.

L. Critique test and discuss in class.

M. Reteach and retest as necessary.

N. Complete appropriate sections of competency profiles.

III. Unit references

A. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

B. Penner, Wayman R. *Residential Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1973.

C. United Steel Products Company. Technical Information Procedure Sheet. Minneapolis, Minnesota, 1972.

D. Wagner, Willis H. *Modern Carpentry*. South Holland, Illinois: Goodheart-Willcox Co., Inc., 1976.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — SUGGESTIONS TO SPEED UP CEILING JOIST INSTALLATION

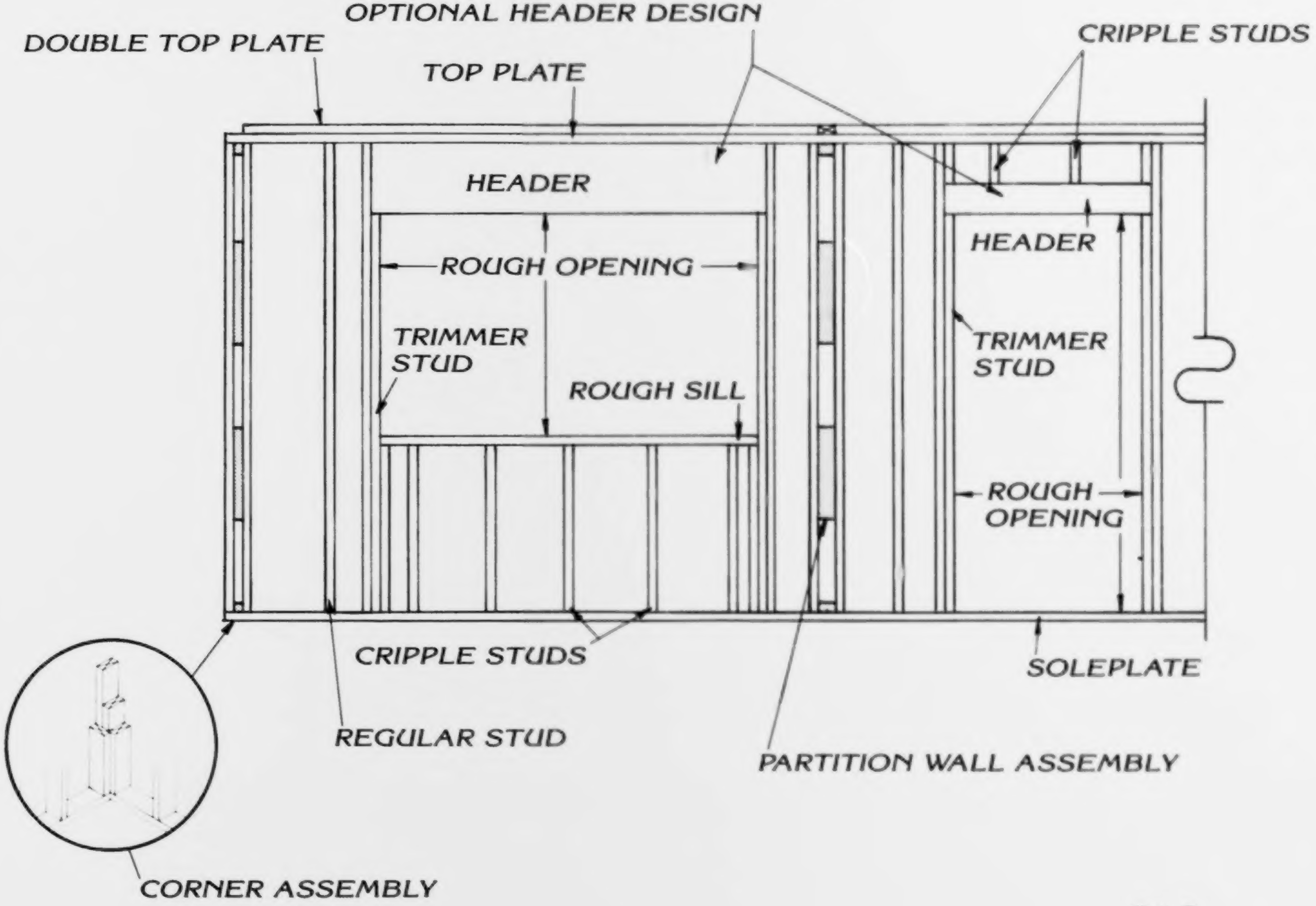
- Cut joist to correct length
- Trim outer ends of joists to correct roof slope
- Have helper hand joists up to someone on top
- Layout joists flat across span at their proper location
- If spacing is the same as studs, nail joists directly above studs, this allows for pipes, flues, ducts and so on that run through the roof to be installed more easily
- Use a carpenter on each end when nailing joists in place

SUGGESTED ACTIVITIES

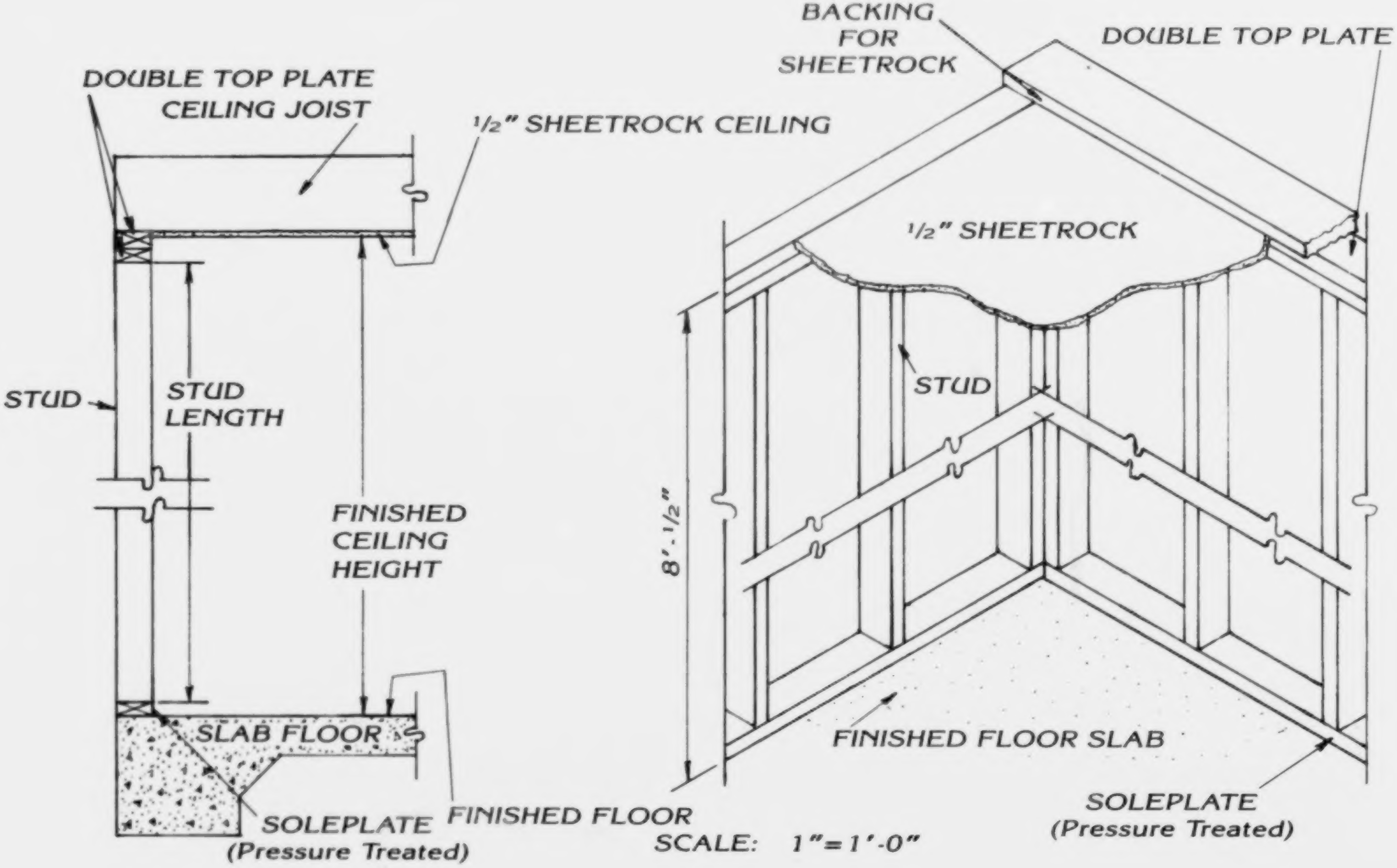
SUPPLEMENT #2 — CEILING JOIST SPACING AND ALLOWABLE SPANS

Species	Grade	Span (feet and inches)					
		2 × 4		2 × 6		2 × 8	
		16" oc	24" oc	16" oc	24" oc	16" oc	24" oc
DOUGLAS FIR-LARCH	2	11-6	10-0	18-1	15-7	23-10	20-7
	3	9-9	7-11	14-8	11-11	19-4	15-9
DOUGLAS FIR SOUTH	2	10-6	9-2	16-6	14-5	21-9	19-0
	3	9-5	7-9	14-2	11-7	18-9	15-3
HEM-FIR	2	10-9	9-5	16-11	13-11	22-4	18-4
	3	8-7	7-0	13-1	10-8	17-2	14-0
MOUNTAIN HEMLOCK	2	9-11	8-8	15-7	13-8	20-7	18-0
	3	8-11	7-3	13-3	10-10	17-6	14-4
MOUNTAIN HEMLOCK-HEM-FIR	2	9-11	8-8	15-7	13-8	20-7	18-0
	3	8-7	7-0	13-1	10-8	17-2	14-0
WESTERN HEMLOCK	2	10-9	9-5	16-11	14-6	22-4	19-1
	3	9-0	7-5	13-9	11-3	18-1	14-10
ENGELMANN SPRUCE ALPINE FIR (Engelmann Spruce-Lodgepole Pine)	2	9-11	8-8	15-6	12-8	20-7	16-8
	3	7-10	6-5	11-9	9-7	15-6	12-8
LODGEPOLE PINE	2	10-3	8-11	16-1	13-3	21-2	17-6
	3	8-4	6-9	12-7	10-3	16-7	13-6
PONDEROSA PINE-SUGAR PINE (Ponderosa Pine-Lodgepole Pine)	2	9-11	8-8	15-7	12-10	20-7	16-10
	3	8-0	6-6	12-0	9-10	15-10	12-11
WHITE WOODS (Western Woods)	2	9-7	8-5	15-1	12-6	20-2	16-5
	3	7-10	6-5	11-9	9-8	15-6	12-8
IDAHO WHITE PINE	2	10-3	8-5	15-3	12-6	20-0	16-5
	3	7-10	6-5	11-9	9-8	15-6	12-8
WESTERN CEDARS	2	9-7	8-5	15-1	13-2	20-0	17-6
	3	8-3	6-9	12-7	10-3	16-7	13-7

Wall and Partition Framing Members

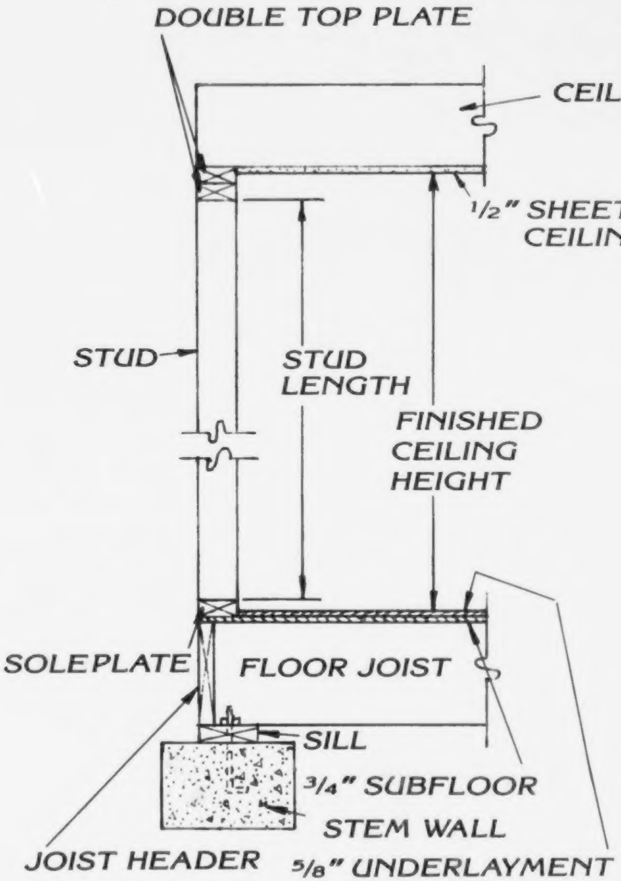

OPTIONAL HEADER DESIGN
DOUBLE TOP PLATE
TOP PLATE
CRIPPLE STUDS
HEADER
ROUGH OPENING
HEADER
TRIMMER STUD
TRIMMER STUD
ROUGH SILL
ROUGH OPENING
CRIPPLE STUDS
SOLEPLATE
REGULAR STUD
PARTITION WALL ASSEMBLY
CORNER ASSEMBLY

Stud Length for a Slab Floor

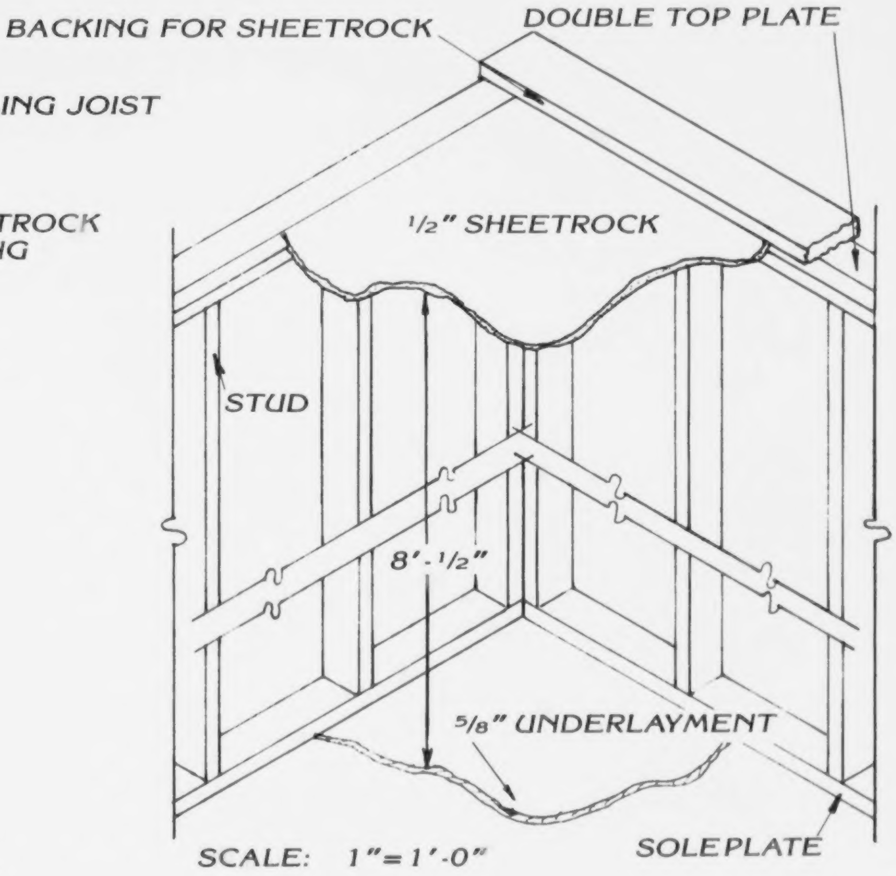

DOUBLE TOP PLATE
CEILING JOIST
1/2" SHEETROCK CEILING
STUD
STUD LENGTH
FINISHED CEILING HEIGHT
SLAB FLOOR
SOLEPLATE (Pressure Treated)
FINISHED FLOOR
BACKING FOR SHEETROCK
DOUBLE TOP PLATE
1/2" SHEETROCK
STUD
8'-1/2"
FINISHED FLOOR SLAB
SOLEPLATE (Pressure Treated)

SCALE: 1"=1'-0"

Stud Length for a Wood Floor

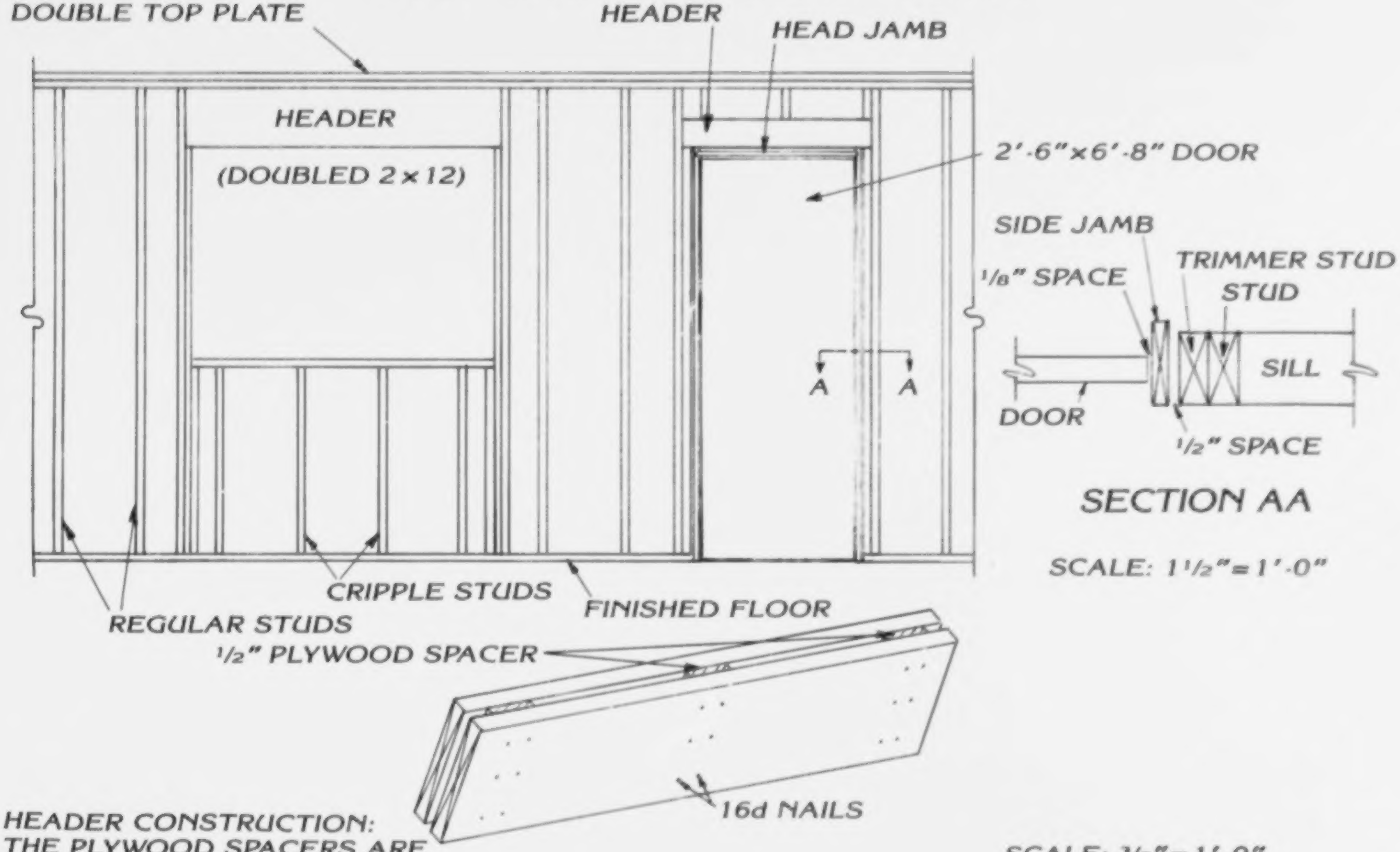

DOUBLE TOP PLATE
CEILING JOIST
1/2" SHEETROCK CEILING
STUD
STUD LENGTH
FINISHED CEILING HEIGHT
SOLEPLATE
FLOOR JOIST
SILL
3/4" SUBFLOOR
STEM WALL
JOIST HEADER
5/8" UNDERLAYMENT

615


BACKING FOR SHEETROCK
DOUBLE TOP PLATE
1/2" SHEETROCK
STUD
8'-1/2"
5/8" UNDERLAYMENT
SCALE: 1" = 1'-0"
SOLEPLATE

616

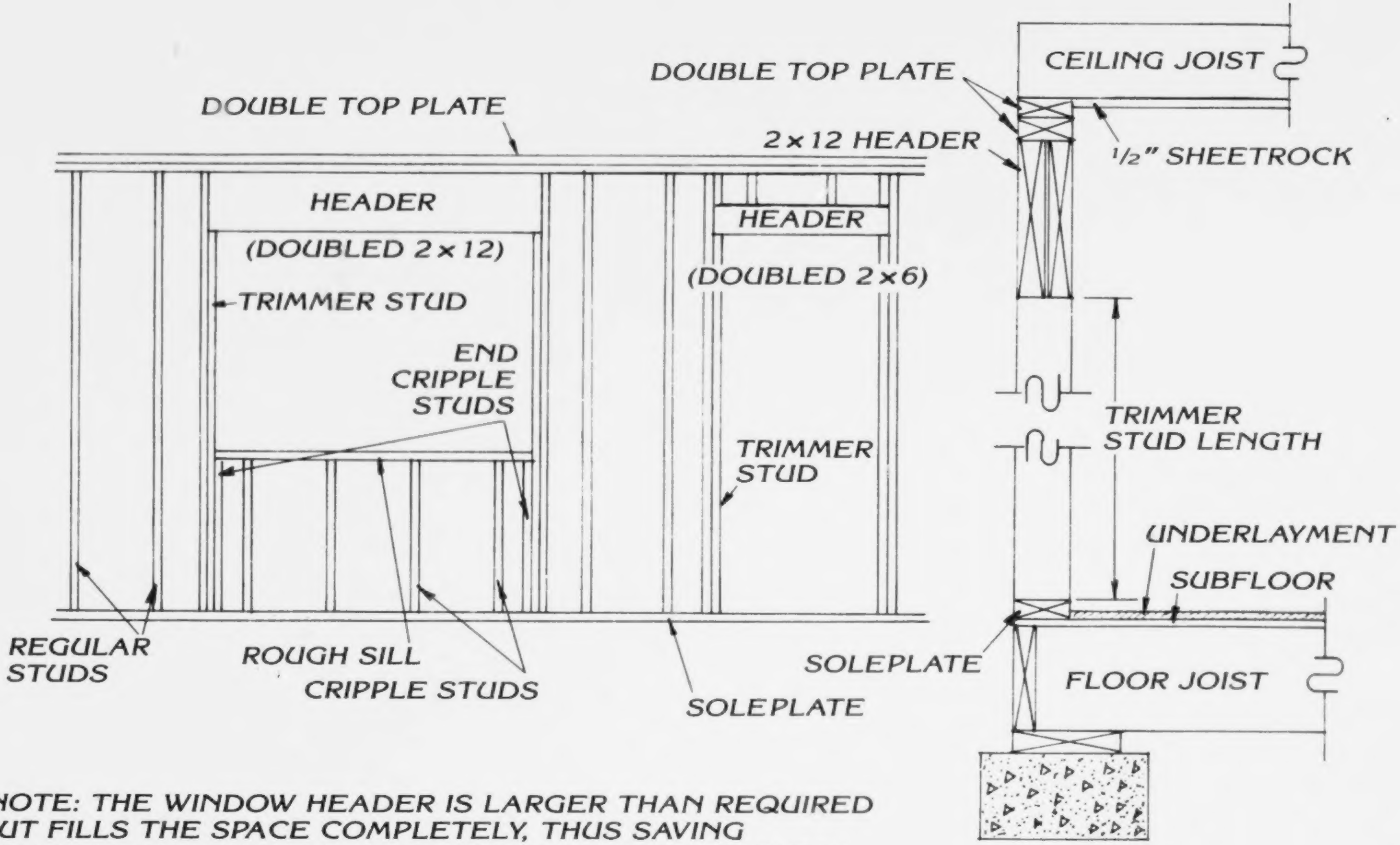
Door and Window Headers


DOUBLE TOP PLATE
HEADER
HEAD JAMB
HEADER
(DOUBLED 2×12)
2'-6"×6'-8" DOOR
A
A
REGULAR STUDS
CRIPPLE STUDS
FINISHED FLOOR
SIDE JAMB
1/8" SPACE
TRIMMER STUD
STUD
SILL
DOOR
1/2" SPACE
SECTION AA
SCALE: 1 1/2"=1'-0"
1/2" PLYWOOD SPACER
16d NAILS

HEADER CONSTRUCTION:
THE PLYWOOD SPACERS ARE
PLACED 16" TO 24" O.C.

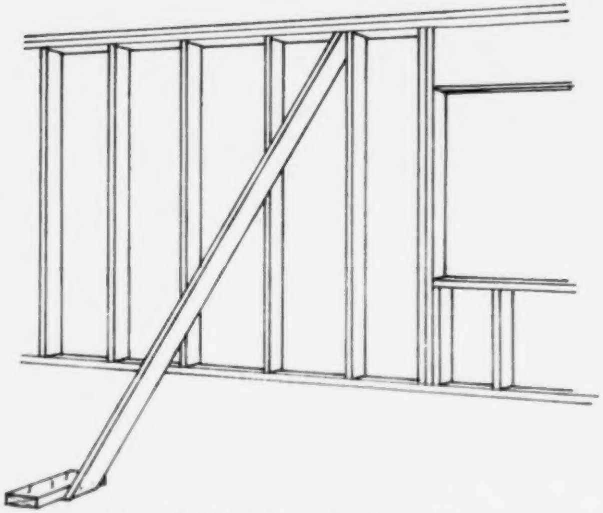
SCALE: 3/8"=1'-0"

Trimmer Studs

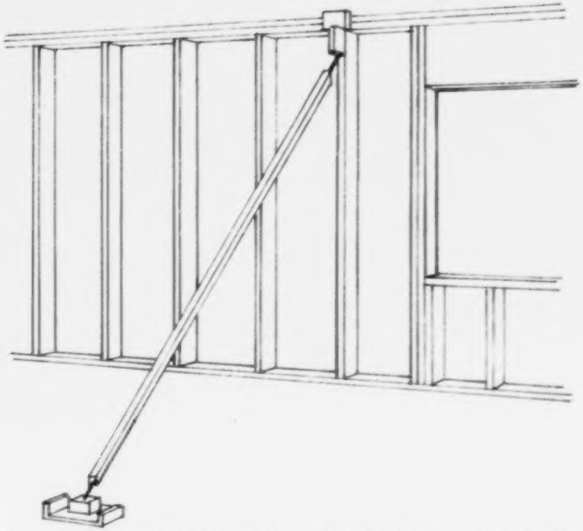

DOUBLE TOP PLATE
HEADER
(DOUBLED 2×12)
TRIMMER STUD
END
CRIPPLE
STUDS
HEADER
(DOUBLED 2×6)
TRIMMER
STUD
REGULAR
STUDS
ROUGH SILL
CRIPPLE STUDS
SOLEPLATE
DOUBLE TOP PLATE
CEILING JOIST
2×12 HEADER
1/2" SHEETROCK
TRIMMER
STUD LENGTH
UNDERLAYMENT
SUBFLOOR
SOLEPLATE
FLOOR JOIST

(NOTE: THE WINDOW HEADER IS LARGER THAN REQUIRED BUT FILLS THE SPACE COMPLETELY, THUS SAVING LABOR IN CUTTING AND ASSEMBLING SHORT CRIPPLES.)

Temporary Bracing

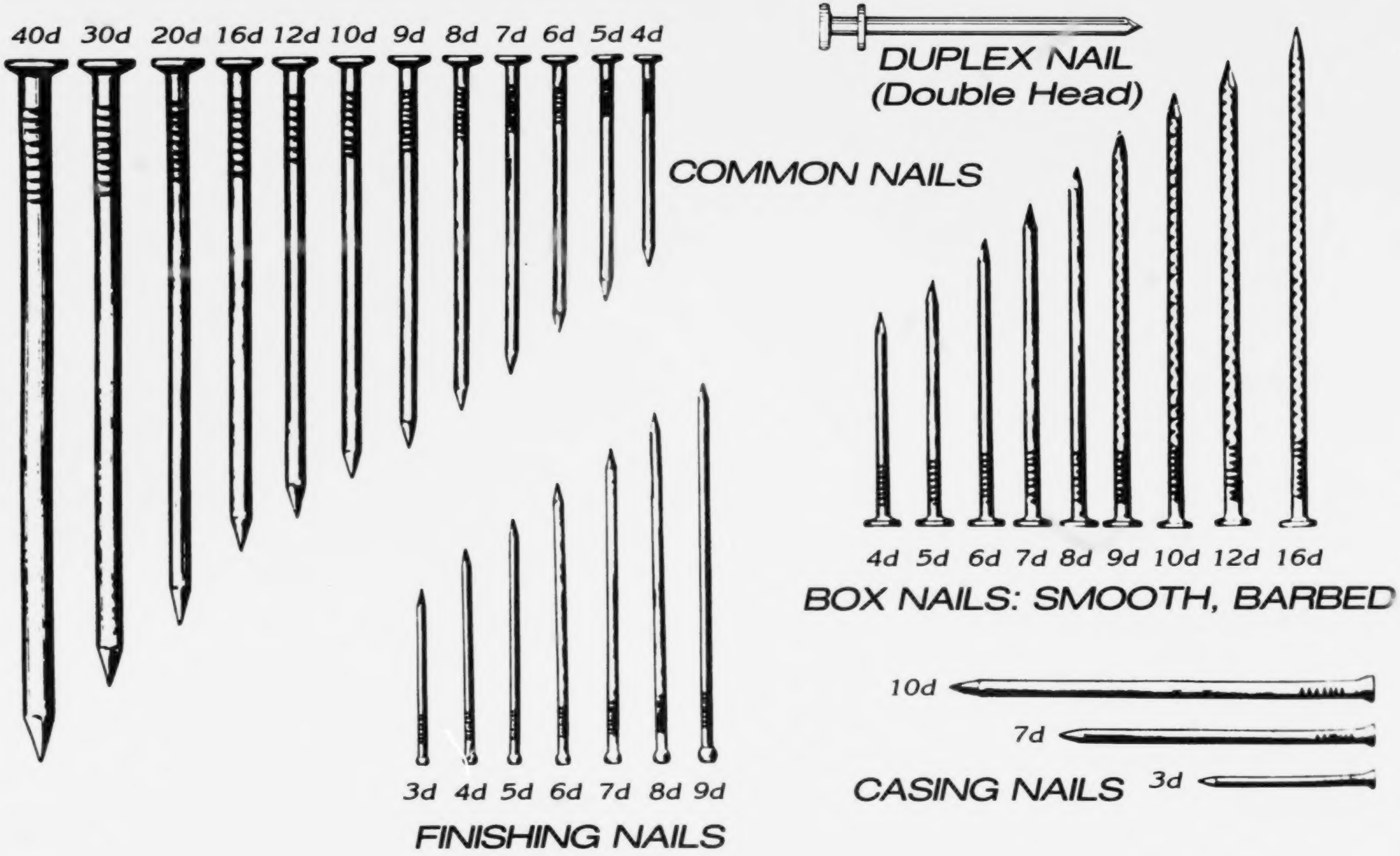


2×4 WALL BRACE



ADJUSTABLE WALL BRACE

Nails


40d 30d 20d 16d 12d 10d 9d 8d 7d 6d 5d 4d
COMMON NAILS
DUPLEX NAIL
(Double Head)
4d 5d 6d 7d 8d 9d 10d 12d 16d
BOX NAILS: SMOOTH, BARBED
10d
7d
3d
CASING NAILS
3d 4d 5d 6d 7d 8d 9d
FINISHING NAILS

Lengths of Nails by Pennyweight

Pennyweight	Length in inches for common, box, and finish nails
2d	1
3d	$1\frac{1}{4}$
4d	$1\frac{1}{2}$
5d	$1\frac{3}{4}$
6d*	2
7d	$2\frac{1}{4}$
8d*	$2\frac{1}{2}$
9d	$2\frac{3}{4}$
10d	3
12d	$3\frac{1}{4}$
16d*	$3\frac{1}{2}$
20d*	4

* Sizes most often used in construction

WALL AND CEILING FRAMING
UNIT II

INFORMATION SHEET

I. Terms and definitions

  A. Bearing wall — Wall that supports the floors and roof directly above it in addition to its own weight

  B. Bearing partition — Partition wall that supports the structure above

  C. Partition — Wall that subdivides space within a building

  D. Stud — Main vertical framing member in walls and partitions

  E. Soleplate — Lowest horizontal member of a wall or partition to which the studs are nailed; rests on the rough floor

  F. Top plate — Upper horizontal structural member of a wall used to carry the rafters or trusses of a roof

  G. Double top plate — Top plate made of two members to allow better stiffening of the wall and for tying together splices, corners, and partitions that are at right angles to a wall

  H. Cripple stud — Any part of a framing stud that is cut less than full size, as over a door or window or under a window opening

  I. Blocking (spacer) — Wood block used as filler piece and support between framing members

  J. Header — Horizontal structural member that supports the load over an opening, such as a window or door

  K. Jamb — Top and sides of a door or window frame that contacts the door or window sash; consists of a head jamb and side jambs

  L. Rough opening — Opening in framing formed by framing members, such as for windows and doors

  M. Rough sill — Lower framing member attached to the top of the bottom cripple studs to form the base of a rough opening for a window

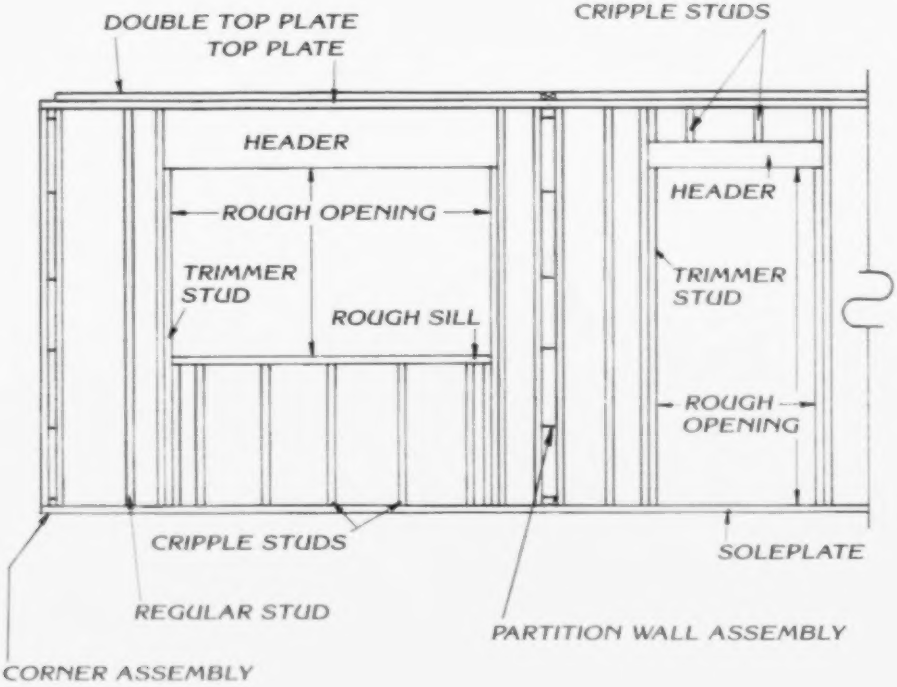
  N. Trimmer — Vertical framing member that forms the sides of rough openings for doors and windows and on which the header rests

  O. Gable — Triangular portion of exterior wall above the eaves at the end of a structure

INFORMATION SHEET

II. Wall and partition framing members (Figure 1)

FIGURE 1


DOUBLE TOP PLATE
TOP PLATE
CRIPPLE STUDS
HEADER
ROUGH OPENING
TRIMMER STUD
ROUGH SILL
HEADER
TRIMMER STUD
ROUGH OPENING
CRIPPLE STUDS
SOLEPLATE
REGULAR STUD
PARTITION WALL ASSEMBLY
CORNER ASSEMBLY

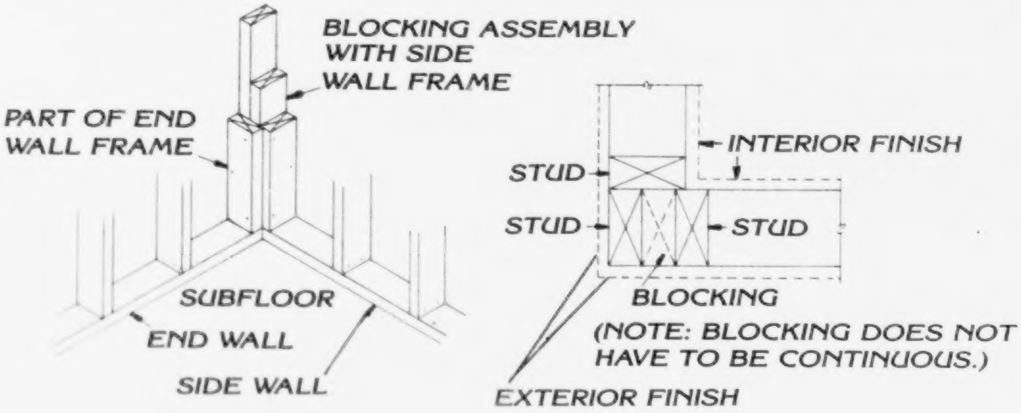
INFORMATION SHEET

III. Methods used to construct outside corners of wall frame (Figures 2 and 3)

(NOTE: The methods shown are just two possible methods; many others exist. The important considerations are a solid corner and nailing surfaces for the interior and exterior wall finishes. Most carpenters try to choose the straightest, least defective studs for corner assemblies. The methods shown can be used for 2×4 or 2×6 studs.)

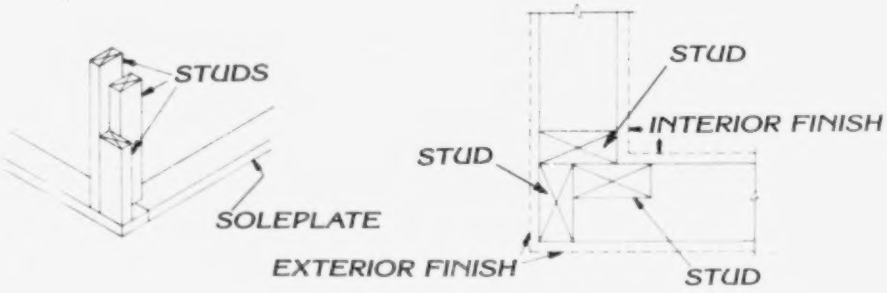
A. Constructed with three full studs and blocking

FIGURE 2


BLOCKING ASSEMBLY WITH SIDE WALL FRAME
PART OF END WALL FRAME
SUBFLOOR
END WALL
SIDE WALL
INTERIOR FINISH
STUD
STUD
STUD
BLOCKING
(NOTE: BLOCKING DOES NOT HAVE TO BE CONTINUOUS.)
EXTERIOR FINISH

B. Constructed with three full studs (no blocking)

FIGURE 3


STUDS
SOLEPLATE
STUD
INTERIOR FINISH
STUD
EXTERIOR FINISH
STUD

INFORMATION SHEET

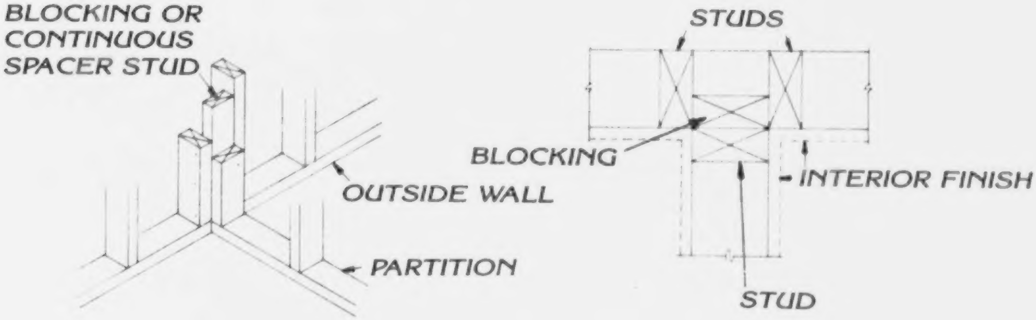
IV. Methods used to construct partition Ts (Figures 4-6)

(NOTE: Several methods for tying in partition walls exist. Some of the more common are shown here.)

A. Constructed with three studs and blocking

(NOTE: This is the most common method and can be used with 2×4 or 2×6 studs.)

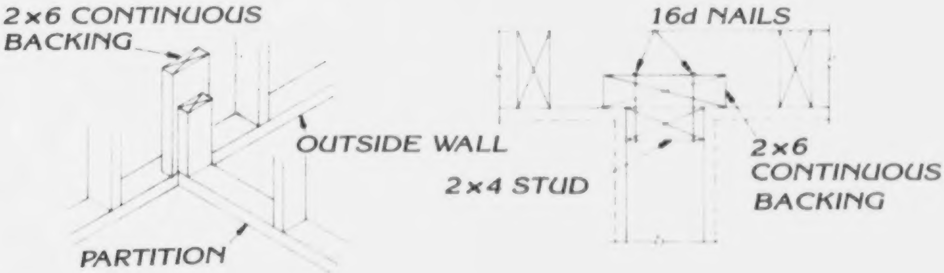
FIGURE 4


BLOCKING OR
CONTINUOUS
SPACER STUD
OUTSIDE WALL
PARTITION
STUDS
BLOCKING
INTERIOR FINISH
STUD

B. Constructed with a continuous backer

(NOTE: The method shown is for 2×4 framing, but variations exist for 2×6 framing.)

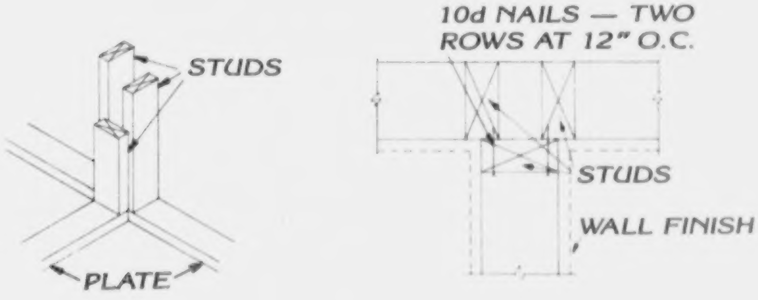
FIGURE 5


2×6 CONTINUOUS
BACKING
OUTSIDE WALL
PARTITION
16d NAILS
2×4 STUD
2×6
CONTINUOUS
BACKING

INFORMATION SHEET

C. Constructed with three studs (no blocking)

FIGURE 6


STUDS
PLATE
10d NAILS — TWO ROWS AT 12" O.C.
STUDS
WALL FINISH

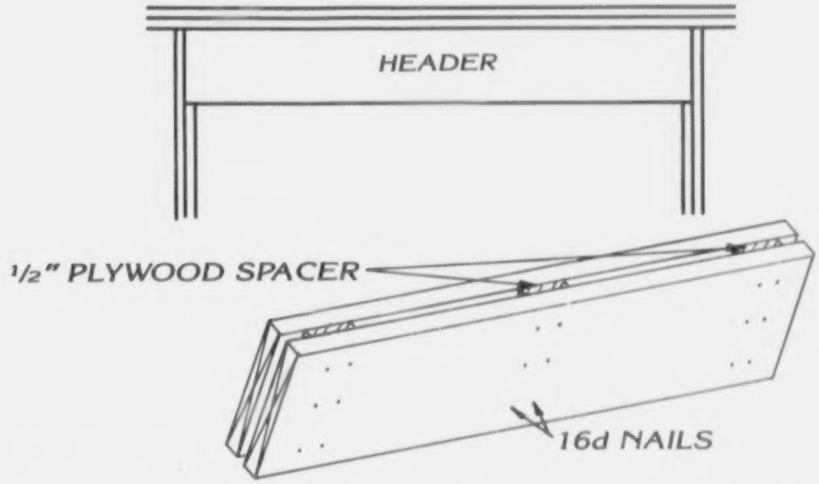
V. Types of headers

(NOTE: There are many different types of headers. These are some of the most common.)

A. Solid or full header (Figure 7)

(NOTE: A full header is used for large openings and fills the area from the rough opening to the bottom of the top plate.)

FIGURE 7

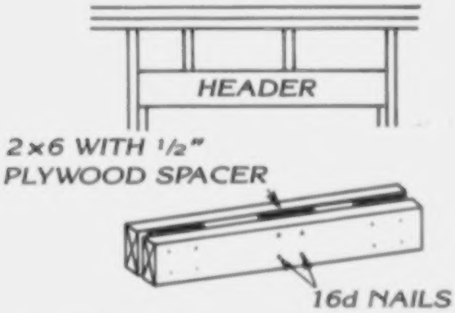

HEADER
1/2" PLYWOOD SPACER
16d NAILS

INFORMATION SHEET

B. Small header with cripples (Figure 8)

(NOTE: A small header with cripples may be used for average size windows and doors and is usually constructed of 2×4s or 2×6s.)

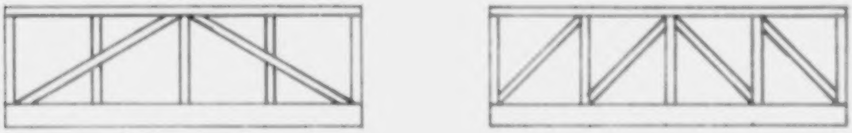
FIGURE 8


HEADER
2×6 WITH ½"
PLYWOOD SPACER
16d NAILS

C. Truss header (Figure 9)

(NOTE: Truss headers are used when the load is especially heavy or the span is extra wide. The design of trusses is usually included in the architectural plans.)

FIGURE 9



D. I-beam header (Figures 10 and 11)

FIGURE 10

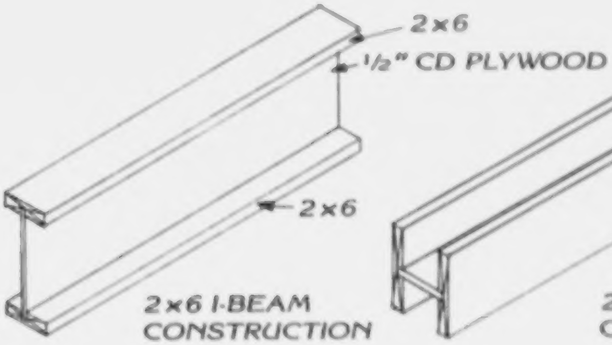
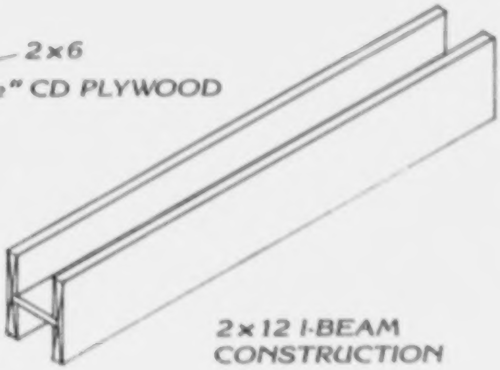

2×6
½" CD PLYWOOD
2×6
2×6 I-BEAM
CONSTRUCTION

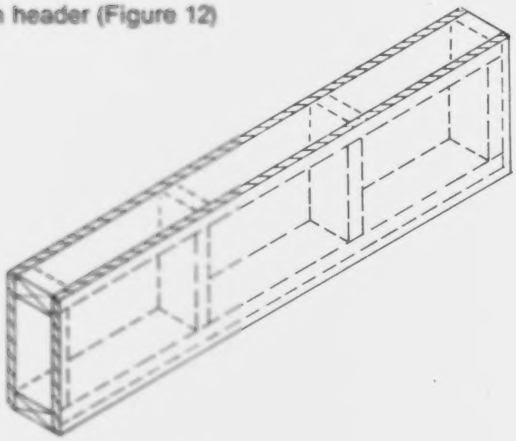
FIGURE 11


2×12 I-BEAM
CONSTRUCTION

INFORMATION SHEET

E. Box beam header (Figure 12)

FIGURE 12



VI. Computing the length of a regular stud

(NOTE: Precut studs are available in 92⅝-inch or 93¼-inch lengths.)

A. Slab floor

1. Determine the height of the finished ceiling from the finished floor including ½-inch clearance for finish material
2. Determine the thickness of the soleplate plus the double top plate
3. Determine the thickness of ceiling material and flooring material

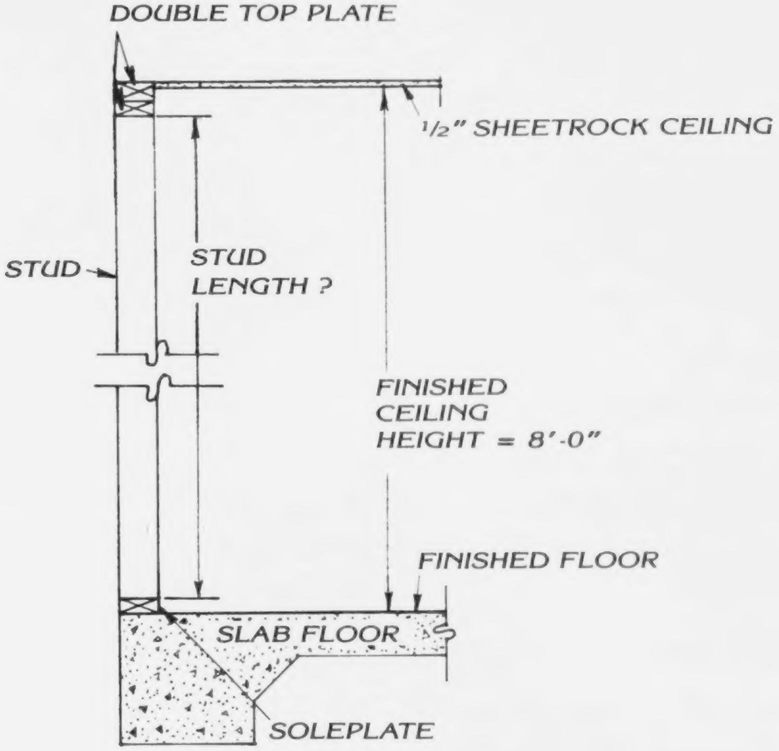
   (NOTE: For carpet or a resilient-type flooring material, the thickness is negligible.)

4. Add the thickness of ceiling and flooring material to the finished ceiling height
5. Subtract the thickness of the plates from the sum achieved in step 4 to obtain the stud length

   EXAMPLE: The desired finished ceiling height is 8 feet, the actual plate thickness is 1 ½ inches, the ceiling thickness is ½ inch, and resilient tile flooring is used. (See Figure 13.)

INFORMATION SHEET

FIGURE 13


DOUBLE TOP PLATE
1/2" SHEETROCK CEILING
STUD
STUD LENGTH ?
FINISHED CEILING HEIGHT = 8'-0"
FINISHED FLOOR
SLAB FLOOR
SOLEPLATE

1. *Finished ceiling height: 8'*
2. *Thickness of soleplate and double top plate: 1 1/2" + 1 1/2" + 1 1/2" = 4 1/2"*
3. *Thickness of ceiling and flooring: 1/2" + 0 = 1/2"*
4. *Total wall frame required height: 8' + 1/2" = 8'- 1/2"*
5. *Required stud length: 8'- 1/2" − 4 1/2" = 7'-8" or 92"*

B. Wood floor

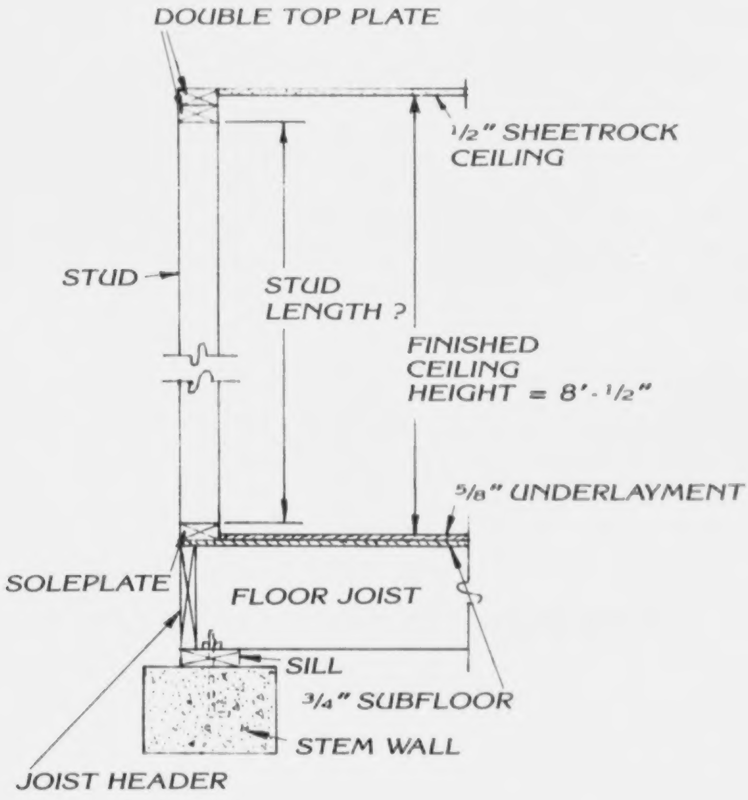
1. Determine the height of the finished ceiling from the finished floor including 1/2-inch clearance for finish material
2. Determine the thickness of the soleplate plus the double top plate
3. Determine the thickness of ceiling material and underlayment
4. Add the thickness of ceiling and underlayment to the finished ceiling height

INFORMATION SHEET

5. Subtract the thickness of the plates from the sum achieved in step 4 for the stud length

EXAMPLE: The desired finished ceiling height is 8'-½", the actual plate thickness is 1 ½ inches, the ceiling thickness is ½ inch, and the underlayment thickness is ⅝ inch. (See Figure 14.)

FIGURE 14


DOUBLE TOP PLATE
½" SHEETROCK CEILING
STUD
STUD LENGTH ?
FINISHED CEILING HEIGHT = 8'-½"
⅝" UNDERLAYMENT
SOLEPLATE
FLOOR JOIST
SILL
¾" SUBFLOOR
STEM WALL
JOIST HEADER

1. *Height of finished ceiling: 8'- ½"*
2. *Thickness of soleplate and double top plate: 1½" + 1½" + 1½" = 4½"*
3. *Thickness of ceiling material and underlayment: ½" + ⅝" = 1⅛"*
4. *Total wall frame required height: 8'- ½" + 1⅛" = 8'-1⅝"*
5. *Required stud length: 8'-1⅝" – 4½" = 7'-9⅛" or 93⅛"*

INFORMATION SHEET

VII. Computing rough opening (R.O.) dimensions for windows (Figure 15)

(NOTE: Rough openings and other sizes are usually furnished by manufacturers; however, some windows consist of a combination of ventilating and fixed units, and the carpenter may need to calculate the rough opening dimensions.)

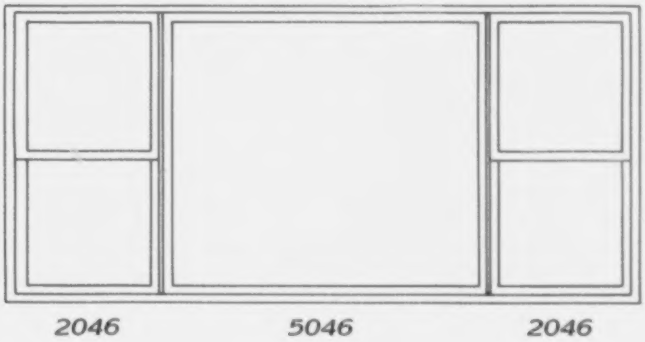
A. Compute horizontal distance for rough opening

1. Add width of window or windows
2. Add width of mullions if required
3. Add two inches for sides of rough opening

B. Add two inches for top and bottom to window height for vertical rough opening

EXAMPLE:

FIGURE 15



Horizontal rough opening

#1 Sash Opening — 2046	2'-0"
#2 Sash Opening — 5046	5'-0"
#3 Sash Opening — 2046	2'-0"
2 mullions (1" each)	0'-2"
Add 1" each side for R.O.	+ 0'-2"
	9'-4"

Vertical rough opening 4'-6" + 2" = 4' - 8"

INFORMATION SHEET

VIII. Compute rough opening (R.O.) dimensions for doors

A. Width

1. Check door schedule for door size
2. Add 3/16 inch to door width for clearance between door and side jambs
3. Add 1 1/2 inches (3/4 inch each) for side jambs
4. Add 3/4 inch (3/8 inch each) for clearance between jamb and trimmer stud
5. Round to the next larger half inch to obtain the actual rough opening width

(NOTE: Some carpenters use width of door plus 2 1/2 inches.)

EXAMPLE:

3'-0" × 7'-0" door

Door width	3'-0"
Door and jamb clearance	3/16"
Side jambs	1 1/2"
Side jamb and trimmer clearance	+ 3/4"
Exact rough opening width	3'-2 7/16"
Actual rough opening width	3'-2 1/2"

B. Height

1. Check door schedule for door size
2. Add 3/32 inch to door height for clearance between door and header jamb
3. Add 3/4 inch for header jamb
4. Add 5/8 inch for clearance under door
5. Add 3/8 inch for header jamb and rough header clearance
6. Round to the next larger half inch to obtain the actual rough opening width (See example on next page)

(NOTE: Some carpenters use height of door plus 2 inches.)

INFORMATION SHEET

EXAMPLE:

3′-0″ × 7′-0″ door

Door height	7′-0″
Door and header clearance	3/32″
Header jamb	3/4″
Header jamb and rough header clearance	3/8″
Bottom clearance	+ 5/8″
Exact rough opening height	7′-1″ 27/32″
Actual rough opening height	7′-2″

IX. Computing length of trimmers for window and door openings

(NOTE: The tops of all windows and doors should be the same height from the floor unless otherwise specified. Adjustments may be necessary if 2×12 material is used.)

A. Slab floor

1. Determine the height of the rough opening from the finished floor

   a. Determine the door height and add 5/8 inch for clearance at the bottom of the door

      (NOTE: Standard doors are 6′-8″ high.)

   b. Add 3/4 inch for jamb header

   c. Add 3/4 inch for clearance between rough header and jamb header

2. Subtract the thickness of the soleplate

EXAMPLE:

Door height	6′-8″
Clearance	5/8″
Jamb header	3/4″
Header clearance	+ 3/4″
	6′-10 1/8″
Soleplate	− 1 1/2″
Trimmer stud length	6′- 8 5/8″

(NOTE: Normal rough opening for a 6′-8″ door should be 6′-10″.)

INFORMATION SHEET

B. Wood floor — Compute the same as for a slab floor, remembering to add the thickness of the underlayment to establish the finished floor

X. Computing length of headers for rough openings

A. Rough header length for doors

(NOTE: If prehung doors are used, check manufacturer's specifications for rough opening size.)

1. Determine rough opening width
2. Check door schedule for door sizes
3. Add 1 1/2" for side jambs
4. Add 1" for clearance to install jambs
5. Add 3" to rough opening width for trimmer studs

EXAMPLE:

For a 3'-0" × 6'-8" door

Door size	3'-0"
Side jambs	1 1/2"
Side jambs and trimmer clearance	+ 1"
Rough opening	3'-2 1/2"
Thickness of trimmer studs	+ 3"
Header size	3'-5 1/2" or 41 1/2"

(NOTE: After computing one header size, subtract the door size from it and use this figure to add to other door sizes to determine header size. You can generally use 5 1/2 inches added to the door width.)

B. Rough header length for windows — Check with manufacturer to determine rough opening size, then add the thickness of the two trimmer studs, also taking into account whether the return on metal windows is to be sheetrock or wood (See Table 1.)

(NOTE: Table 1 gives the size of headers normally required for various rough opening widths with several load conditions. It is to be used as a guide only. Refer to plans and local regulations for additional restrictions.)

INFORMATION SHEET

TABLE 1 Maximum span for headers (exterior)

Header material (Two members on edge)	Load Single Story	 Two Story	 Three Story
2×4	3′-6″	2′-6″	2′
2×6	6′	5′	4′
2×8	8′	7′	6′
2×10	10′	8′	7′
2×12	12′	9′	8′

XI. Construction details that should be added during wall framing

- A. Openings for heating ducts
- B. Backing and blocking for plumbing fixtures
- C. Framing for recessed cabinets and electrical panels
- D. Backing and blocking for towel bars
- E. Backings for various appliances
- F. Rough openings for air ducts, exhaust fans, and disappearing stair units
- G. Corner blocks for nailing base
- H. Framing for chimney and fireplace
- I. Framing for pocket-type sliding doors
- J. Rough openings for stairwells
- K. Backing nailers for ceiling materials

XII. Methods used to brace walls

A. Permanent bracing

(NOTE: Be sure wall is square and plumb before nailing braces.)

1. Plywood sheathing (at least on the corners)
2. Let-in corner bracing with 1×4 solid lumber

   (NOTE: This type of bracing is done by marking each stud, cutting out a recess in each stud the thickness of the brace, and then nailing the brace in place so that the face of brace is flush with face of each stud. Let-in bracing is set at 45° when possible. Sometimes because of openings this cannot be accomplished.)

3. Metal bracing

INFORMATION SHEET

B. Temporary bracing (wind bracing)

1. 2×4 wall brace (used inside or outside)
2. Adjustable, metal wall brace

XIII. Pennyweights of nails most often used in framing

A. 6d
B. 8d
C. 16d
D. 20d

XIV. Considerations to be made before selecting joist size and spacing

A. Type of ceiling finish
B. Construction above ceiling
C. Use of attic space
D. Joist span
E. Species and grade of lumber

XV. Ceiling joist size and allowable spans

(NOTE: The actual allowable span for joists will depend on the species and grade of lumber used as well as the size and spacing. Additionally, the load to be carried must be considered. These figures are given only as representatives. Refer to plans and allowable spans for the specific lumber being used for actual construction.)

Span (feet and inches)

2×4 Joist

16" OC	24" OC
7'-10" to 11'-6"	6'-5" to 10'-0"

2×6 Joist

16" OC	24" OC
11'-9" to 18'-1"	9'-7" to 15'-7"

2×8 Joist

16" OC	24" OC
15'-6" to 23'-10"	12'-8" to 20'-7"

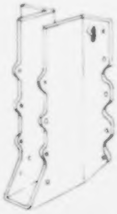
INFORMATION SHEET

XVI. Methods used to support ceiling joists (Figures 16-19)

A. Metal joist hangers

EXAMPLE:

FIGURE 16



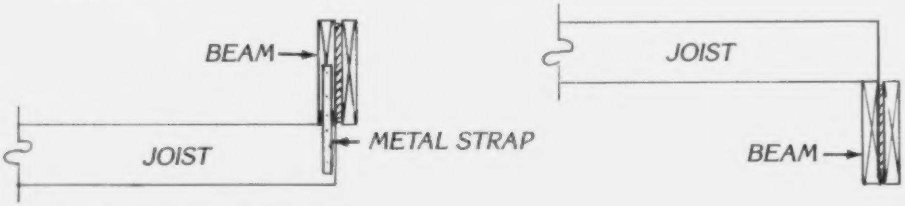
B. Supported by beam (above or below)

EXAMPLES:

1. Above

2. Below

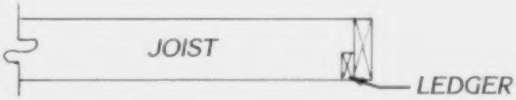
FIGURE 17


BEAM
METAL STRAP
JOIST
JOIST
BEAM

C. Beam with a ledger

EXAMPLE:

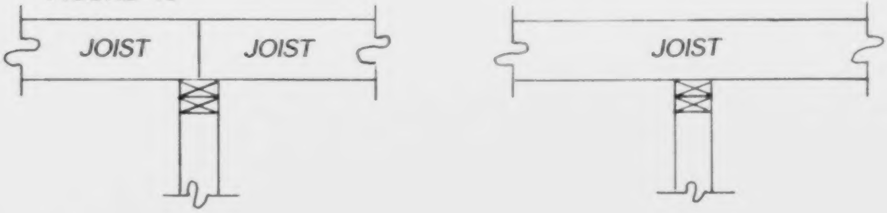
FIGURE 18


JOIST
LEDGER

D. Wall supported

EXAMPLE:

FIGURE 19


JOIST
JOIST
JOIST

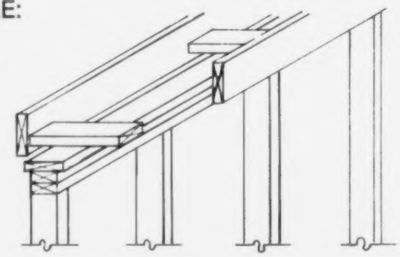
INFORMATION SHEET

XVII. Methods used to anchor ceiling joists to partition walls (Figures 20-22)

A. Nailing strip and blocking

EXAMPLE:

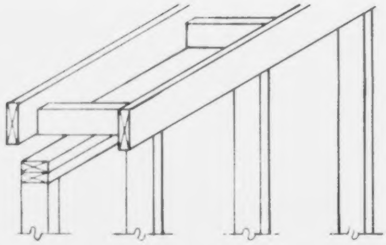
FIGURE 20



B. Blocking only

EXAMPLE:

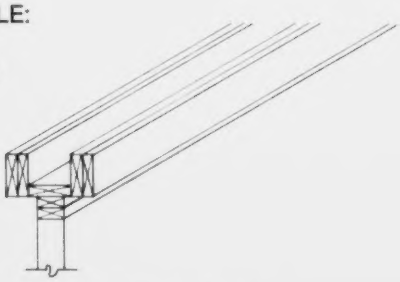
FIGURE 21



C. Solid blocking with double joist

EXAMPLE:

FIGURE 22



XVIII. Estimating material for ceiling joist

A. Determine size and spacing for joist from plans

B. Determine number of joists required by multiplying wall length by the constant for the spacing used

INFORMATION SHEET

1. 12″ on center

    a. Multiply wall length by 1

    b. Add one joist

    EXAMPLE: (Use 2×4 joists for a room 12′ –0″ × 12′ –0″)

    1. 12′ –0″ × 1 = 12 joists
    2. 12 joists + 1 = 13 joists
    3. 13 2×4 joists needed

2. 16″ on center

    a. Multiply wall length by 3/4 (.75)

    b. Add one joist

    EXAMPLE: (Use 2×6 joists for a room 10′ –8″ × 12′ –0″)

    1. 12′ –0″ × .75 = 9.00 or 9 joists
    2. 9 joists + 1 = 10 joists
    3. 10 2×6 joists needed

3. 24″ on center

    a. Multiply wall length by 1/2 (.50)

    b. Add one joist

    EXAMPLE: (Use 2×8 joists for a room 9′ – 10″ × 12′ –6″)

    1. 12′ –6″ × .50 = 6.25 or 7 joists
    2. 7 joists + 1 = 8 joists
    3. 8 2×8 joists needed

    (NOTE: Multiply the full length of the building including fractional feet times the constant for the joist spacing. For any fractions in your answer, round up to the next whole number.)

C. Determine length of joists

INFORMATION SHEET

1. If allowable span for joist is equal to or greater than the width of the building, the joist length will be the same as the building width

2. If allowable span for joist is less than width of building, the joist length will be the distance from the outside of the outside wall to the opposite side of the bearing partition plus 6 inches for overlap

   EXAMPLE: If the distance from the outside of the outside wall to the opposite side of the bearing partition is 9′ −8″, then the joists would have to be 10′ −2″ (9′ −8″ + 6″.)

3. Use the next longest length of material

   (NOTE: Generally, joists will not be cut to size where they overlap on bearing partitions. For instance, in the example above 12-foot lumber would be used and would not be cut down to 10′ −2″ because of the cost in time and labor.)

D. Multiply number of joists for each span times the number of spans for that length to determine the total number of boards needed

EXAMPLE: 2×6 joists are to be used 24″ o.c. in an office building 42′ −0″ × 28′ −4″; a bearing partition runs the length of building 11′ −6″ from the nearer outside wall measured from the outside of the building to the center of the partition

1. 2×6 joists, 24″ o.c.

2. Number of joists = $(28 \times \frac{1}{2}) + 1$

   $14 + 1$

   15

3. Length of joists

   Span A = (11′ −6″ + 1$\frac{3}{4}$″) + 6″ overlap

   11′ −7$\frac{3}{4}$ + 6″

   12′ −1$\frac{3}{4}$

   Span B = 28′ −4″ − 11′ −6″ + 1$\frac{3}{4}$″ + 6

   16′ −10″ + 1$\frac{3}{4}$″ + 6″

   16′ −11$\frac{3}{4}$″ + 6″

   17′ −5$\frac{3}{4}$″

INFORMATION SHEET

Use 14-foot material for Span A and 18-foot material for Span B

4. Number of 14-foot 2×6s = 15 × 1

15

Number of 18-foot 2×6s = 15 × 1

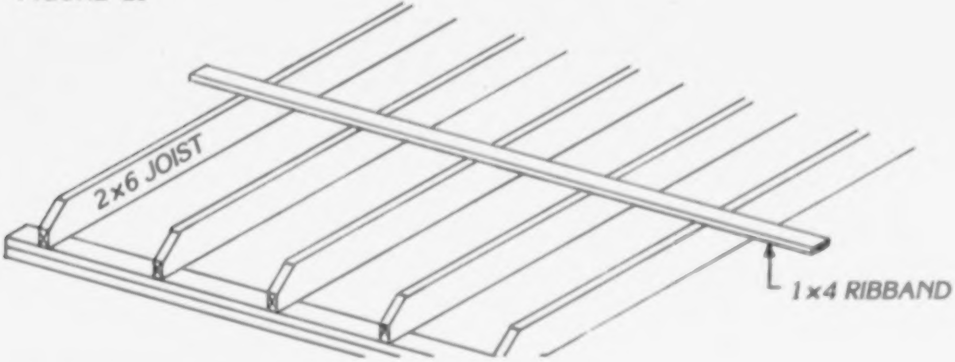
15

XIX. Methods used to protect joists from twist and bow

A. Use 2×4 ribband nailed across tops of joists

EXAMPLE:

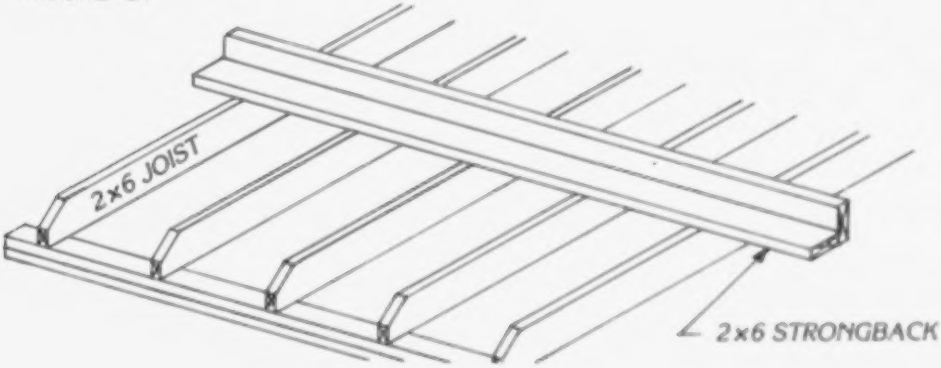
FIGURE 23


2×6 JOIST
1×4 RIBBAND

B. Use strongbacks nailed across top of joist

EXAMPLE:

FIGURE 24


2×6 JOIST
2×6 STRONGBACK

INFORMATION SHEET

XX. Types of finishes used on ceilings

A. Plaster

B. Drywall

C. Acoustical

1. Glue to drywall or plaster
2. Glue or nail to furring strips
3. Drop in metal grid system

D. Suspended ceiling metal grid system

(NOTE: For sound proofing purposes sometimes drywall is attached to a resilient channel that has been attached to the ceiling joists.)

E. Heavy timber ceiling with or without exposed beams

XXI. Estimating amount of materials needed for wall and partition framing

A. Wall plates (2×4s or 2×6s)

1. Determine the lineal footage of all outside walls, including openings
2. Determine the lineal footage of all inside walls, including partitions and openings
3. Multiply the total inside and outside lineal footage by three

   (NOTE: There are three plates: soleplate, top plate, and double top plate. Soleplate should be treated if used on concrete.)

4. Divide total lineal footage obtained in step 3 by sixteen and round up to the next full number to get the number of sixteen-foot 2×4s needed for plates

   (NOTE: Plate material is usually ordered in sixteen-foot lengths.)

B. Studs, 16 inches on center

(NOTE: Studs may be purchased precut or may be cut on the job from eight-foot or sixteen-foot 2×4s or 2×6s.)

1. Determine the lineal footage of all outside and inside walls
2. Allow one stud for each lineal foot of wall
3. If sixteen-foot material is used, divide the total achieved in step 2 by two for the number of pieces of sixteen-foot material needed for studs

C. Studs for gable ends

1. On buildings with gable roofs, use one-fourth the plate length for determining the number of gable studs needed on 2′-0″ centers at each gable end

INFORMATION SHEET

2. Multiply one-half the plate length by three-quarters if the gable studs are on 16-inch centers to determine the number needed

3. Determine to the nearest whole foot the length of the longest gable stud from the double plate to the top of the roof

   (NOTE: One piece of stud material will make a long and a short gable stud; this is why only one-half of the plate length is used.)

4. Order number calculated in step 1 or 2 in the next longest length

D. Headers

(NOTE: The use of 2×12 headers requires more material, but the time saved more than makes up for the difference.)

1. From the door and window schedule determine size of all doors and windows

   (NOTE: List each door and window separately.)

2. Add 5 1/2 inches to each door and window width

3. Double the length of header for each door and window

4. Combine lengths obtained in step 3 into convenient lengths for ordering and to minimize waste

   EXAMPLE: For three headers of 4′-10″, 4′-10″, and 3′-11″, use 14-foot 2×12s

5. Order enough 1/2-inch CD plywood to cut up for spacers

E. Diagonal bracing (if used)

(NOTE: Diagonal bracing is required at each end of all exterior walls. These braces run from bottom plate at an approximate angle of 45 degrees. Walls 8′-0″ high would require material twelve feet long for each brace.)

1. Determine the number of outside and inside corners in the exterior walls

2. Multiply the number of corners by two to determine the number of twelve-foot 1×4s or metal strips needed for bracing

F. Ceiling joists on sixteen-inch centers

1. Determine the size of joists needed from specifications

2. Determine the length of the longest wall

3. Order number of ceiling joists equal to one more than three fourths times the wall length

   (NOTE: A building greater than sixteen feet wide will require a combination of lengths of joists.)

WALL AND CEILING FRAMING
UNIT II

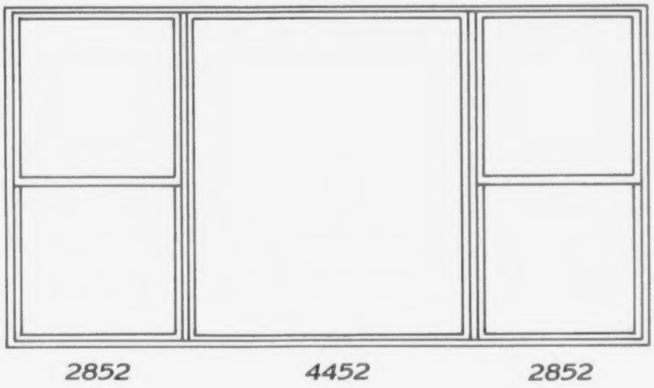
ASSIGNMENT SHEET #1 — CALCULATE ROUGH OPENING DIMENSIONS FOR WINDOWS

NAME ______________________________ SCORE ______________

To install windows properly, a carpenter must be able to calculate sizes of rough openings. The rough opening must provide a secure setting for the window while allowing the carpenter enough room to work.

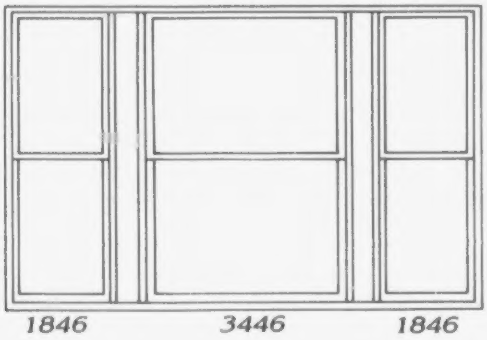
Calculate rough opening dimensions for the combination units listed. Give both the width and the height.

A. Combination double-hung and fixed windows with $1\frac{1}{2}$-inch mullions



Rough opening width ____________ height ____________

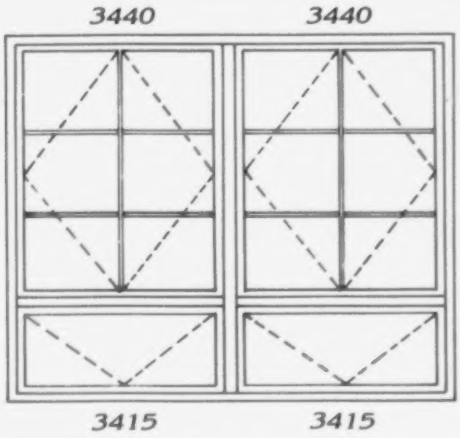
B. Combination of three double-hung windows with 4-inch mullions



Rough opening width ____________ height ____________

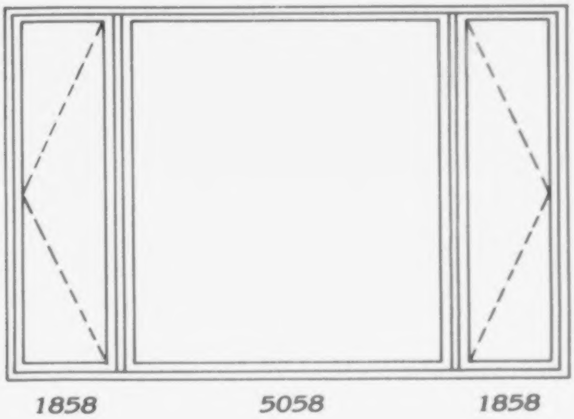
ASSIGNMENT SHEET #1

C. Combination casement and awning windows with 2-inch mullions


3440
3440
3415
3415

Rough opening width ____________ height ____________

D. Combination multi-use and fixed windows with 1½-inch mullions


1858
5058
1858

Rough opening width ____________ height ____________

WALL AND CEILING FRAMING
UNIT II

ASSIGNMENT SHEET #2 — ESTIMATE MATERIALS FOR CEILING JOISTS

NAME ______________________________ SCORE ______________

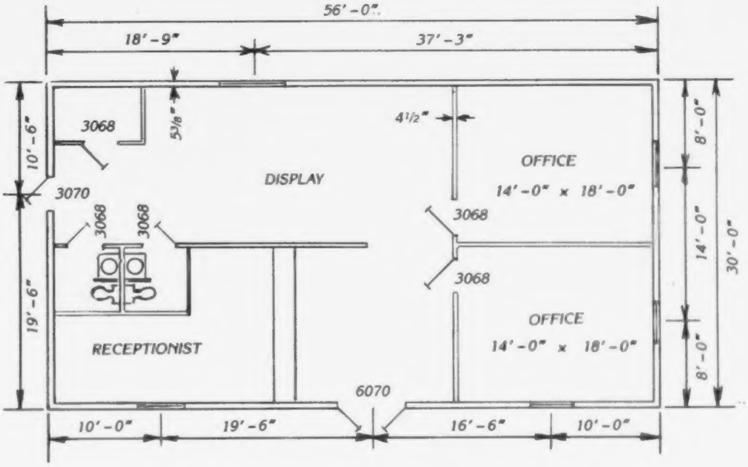
Accurate estimating of framing materials saves time and money. This assignment will help you to better understand estimating and the practice will help you to become proficient when estimating materials. Calculate material needed for ceiling joists from the floor plan and information on the next page.

A. Number ____________ Length ____________

B. Number ____________ Length ____________

C. Number ____________ Length ____________

ASSIGNMENT SHEET #2


56'-0"
18'-9"
37'-3"
5 3/8"
4 1/2"
3068
3070
3068
3068
DISPLAY
OFFICE
14'-0" x 18'-0"
3068
3068
OFFICE
14'-0" x 18'-0"
RECEPTIONIST
6070
10'-6"
19'-6"
8'-0"
14'-0"
8'-0"
30'-0"
10'-0"
19'-6"
16'-6"
10'-0"

Use plan above to calculate length and number of ceiling joists needed.

A. Set 2×8 joists 12″ on center

B. Set 2×6 joists 16″ on center

C. Set 2×6 joists 24″ on center

WALL AND CEILING FRAMING
UNIT II

ASSIGNMENT SHEET #3 — ESTIMATE MATERIALS FOR WALL AND PARTITION FRAMING

NAME ______________________________ SCORE ______________

An accurate estimate of framing material saves time and money. Calculate the framing material needed for wall and partition framing from the floor plan on the next page.

A. Wall plates (2×4s, 16 feet long)______________________________

B. Studs (2×4s, 16 feet long)______________________________

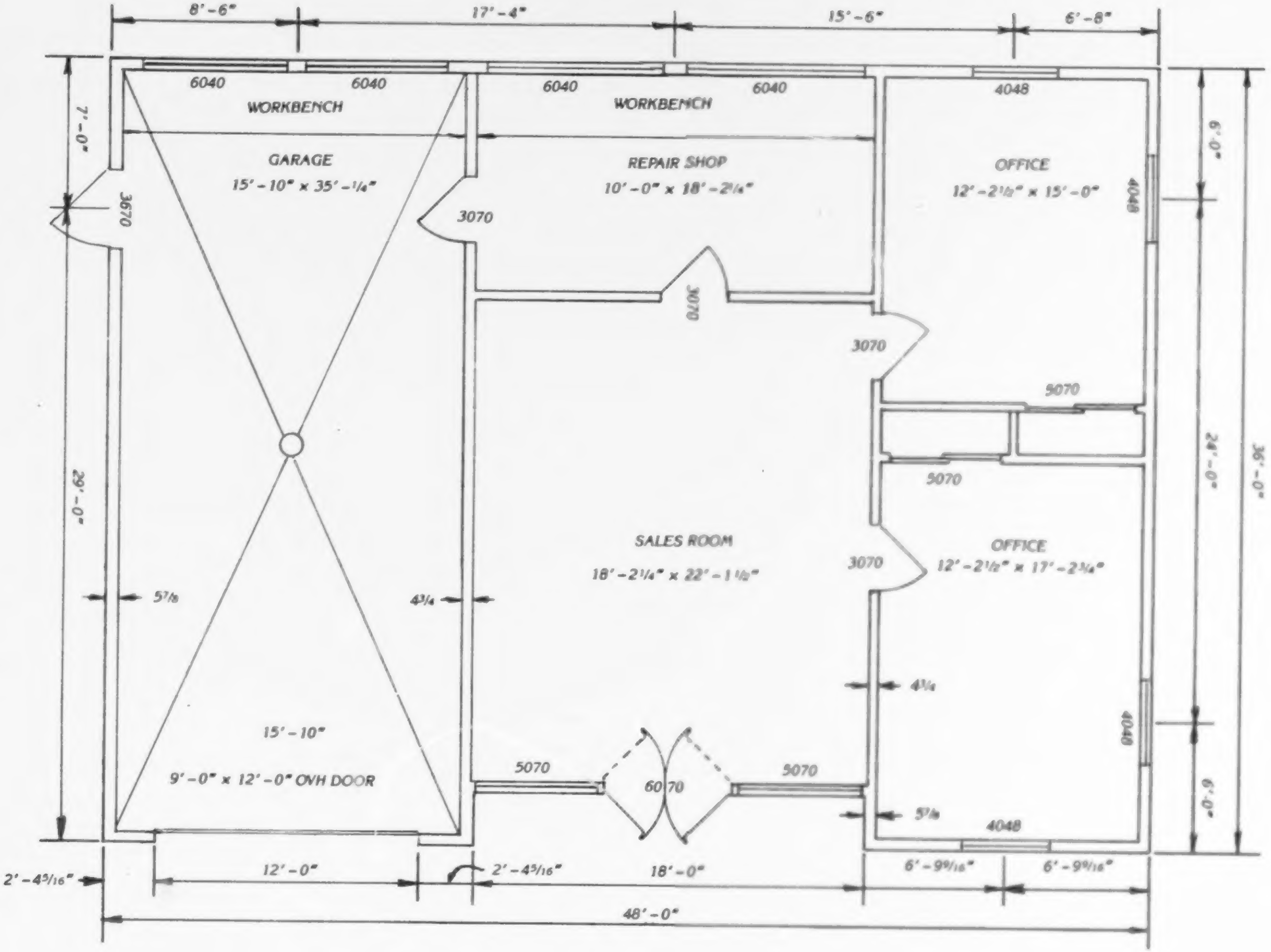
C. Headers (2×12s)______________________________

____

____

D. Diagonal bracing (1×4s, 12 feet long)______________________________

ASSIGNMENT SHEET #3


8'-6"
17'-4"
15'-6"
6'-8"
6040
6040
6040
6040
4048
WORKBENCH
WORKBENCH
7'-0"
GARAGE
15'-10" x 35'-1/4"
REPAIR SHOP
10'-0" x 18'-2¼"
OFFICE
12'-2½" x 15'-0"
4048
6'-0"
3670
3070
3070
3070
5070
5070
24'-0"
36'-0"
29'-0"
SALES ROOM
18'-2¼" x 22'-1½"
3070
OFFICE
12'-2½" x 17'-2¾"
5⅞
4¾
4¾
4048
15'-10"
9'-0" x 12'-0" OVH DOOR
5070
6070
5070
6'-0"
5⅞
4048
2'-4⁵⁄₁₆"
12'-0"
2'-4⁵⁄₁₆"
18'-0"
6'-9⁹⁄₁₆"
6'-9⁹⁄₁₆"
48'-0"

WALL AND CEILING FRAMING
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

A. Width 10′-1″

Height 5′-4″

B. Width 7′-6″

Height 4′-8″

C. Width 7′-0″

Height 5′-9″

D. Width 8′-9″

Height 5′-10″

Assignment Sheet #2

A. 114 joists 16 feet long

B. 86 joists 16 feet long

C. 58 joists 16 feet long

Assignment Sheet #3

(NOTE: Because estimating answers will vary considerably, answers should be evaluated to the satisfaction of the instructor.)

A. 54

B. 144

C. 12 headers 12 feet long

4 headers 14 feet long

2 headers 8 feet long

D. 14

WALL AND CEILING FRAMING
UNIT II

JOB SHEET #1 — LAY OUT WALL AND PARTITION LOCATIONS ON FLOOR

I. Tools and materials

   A. Chalk line

   B. 100-foot tape

   C. Folding rule or steel tape

   D. Claw hammer

   E. 16d nails

   F. Floor plan

   G. Framing square

II. Procedure

   A. Lay out outside walls

      1. Measure in the width of soleplate from the outside edge of the box sill on a wood floor or from the outside of the foundation on a slab floor; mark this distance

         (NOTE: On a wood floor, start a nail at each mark.)

      2. Stretch a chalk line between marks and snap line

         (NOTE: If laying off a slab floor, you will need a helper to hold the other end of the line. For a wood floor, fasten the line to the nails.)

         a. Make sure the line is sufficiently chalked

         b. Pull the line tight from one end

            (NOTE: Have helpers hold each end of the line or fasten it to the nails.)

         c. Place one thumb on the line approximately in the center

         d. Hold line firmly to the floor

         e. Carefully lift one side of the line with the other hand and let it snap to the floor

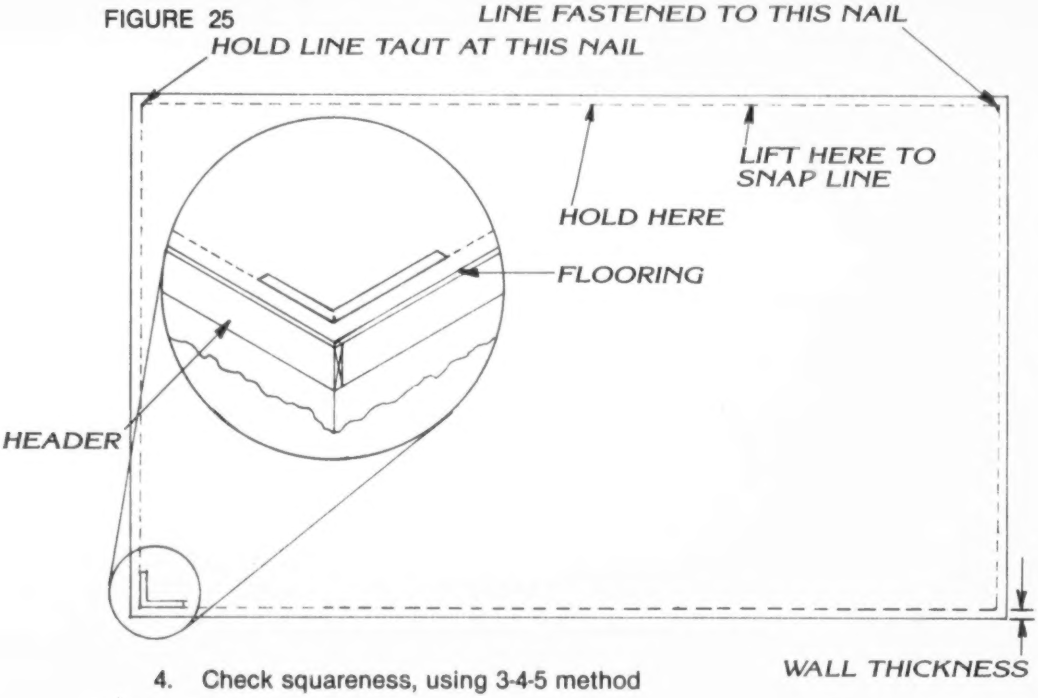
         f. Repeat the procedure for the other half of line

            (NOTE: This operation should result in a straight line that represents the inside face of the outside wall soleplate.)

JOB SHEET #1

3. Square off from chalk line to mark other outside walls (Figure 25)

FIGURE 25


LINE FASTENED TO THIS NAIL
HOLD LINE TAUT AT THIS NAIL
LIFT HERE TO SNAP LINE
HOLD HERE
FLOORING
HEADER
WALL THICKNESS

4. Check squareness, using 3-4-5 method

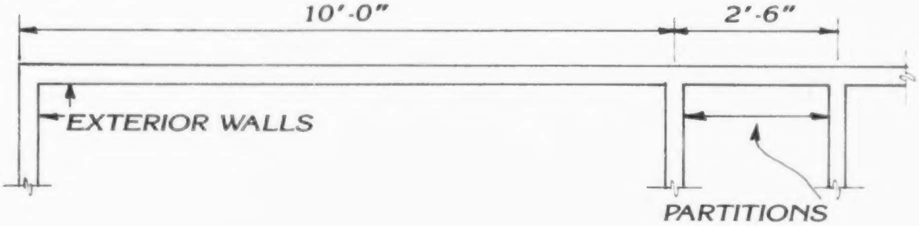
B. Lay out inside walls (Figures 26 and 27)

(NOTE: Lay out all the walls running the length of the building first, then the ones running the width of the building.)

1. Mark one side of each partition on outside walls

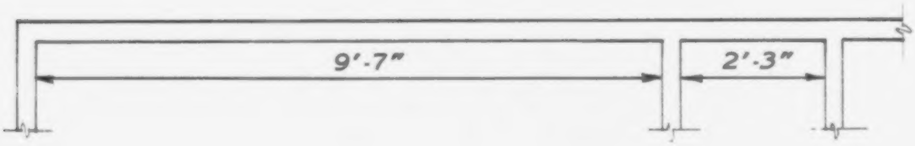
(NOTE: Some floor plans are dimensioned by rooms, and some are dimensioned center to center on partitions.)

FIGURE 26


10'-0"
2'-6"
EXTERIOR WALLS
PARTITIONS

JOB SHEET #1

FIGURE 27



2. Mark width of soleplate
3. Square off from exterior wall mark
4. Stretch chalk line taut along length of partition and snap line
5. Repeat procedure for other side of wall
6. Continue steps to mark both sides of all partitions, using other partition marks to square partitions that do not meet exterior wall

C. Clean work area and put away tools and materials

WALL AND CEILING FRAMING
UNIT II

JOB SHEET #2 — CUT STUDS, TRIMMERS, CRIPPLES, AND HEADERS TO LENGTH

I. Tools and materials

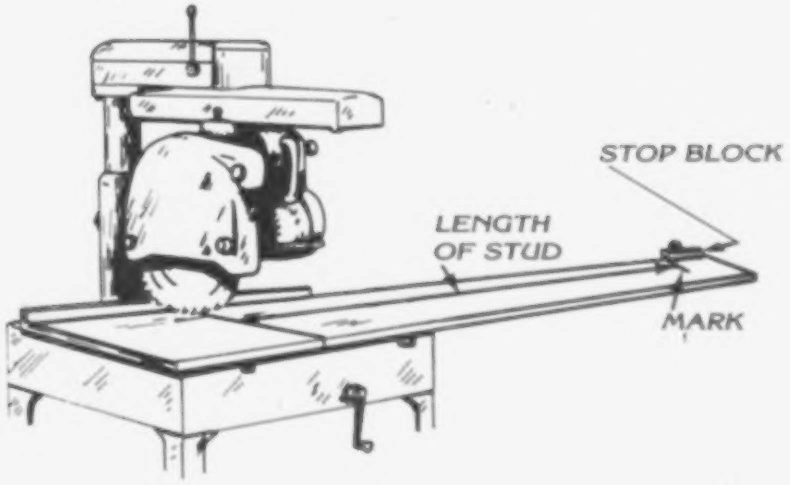
- A. Radial arm saw (with extensions)
- B. Folding rule or steel tape
- C. Claw hammer
- D. C clamp
- E. 16-foot 2×4s or 2×6s
- F. 16d box nails
- G. 2×12s
- H. ½-inch plywood

II. Procedure

- A. Cut wall studs
    - 1. Determine number needed
    - 2. Determine length of full studs
    - 3. Set up radial arm saw to cut studs
        - a. Measure from the right side of the blade the length of the stud and make a mark on the extension table (See Figure 28.)

JOB SHEET #2

FIGURE 28



b. Cut a scrap piece of 2×4 about sixteen inches long

c. Nail or clamp scrap piece to table at mark

(NOTE: Undercut the block slightly.)

4. Cut studs from sixteen-foot material

(NOTE: Studs precut to size can be purchased.)

a. Square right end of stud material

b. Slide material along table until it touches the stop block

CAUTION

Do not bump block so hard that it is moved out of position. Check block occasionally to be sure that it has not moved.

c. Cut first stud

CAUTION

Follow all safety rules concerning the radial arm saw.

d. Check stud for correct length

e. Adjust setup to cut remainder of studs

JOB SHEET #2

f. Repeat previous steps to cut remainder of studs

(NOTE: Check every fifteen to twenty studs to be sure they are uniform in length.)

B. Cut trimmer studs

1. Determine lengths needed
2. Determine number of each length needed
3. Set up saw for longest trimmer stud
4. Cut longest trimmer stud

   (NOTE: Use shortest possible material to cut trimmer studs.)

5. Repeat procedure for each length of trimmer stud, cutting the next shorter length each time

C. Cut cripple studs

1. Determine lengths needed
2. Determine number of each length needed
3. Set up saw for longest cripple stud
4. Cut longest cripple stud

   (NOTE: Use shortest possible material to cut cripple studs.)

5. Repeat procedure for each length of cripple stud, cutting the next shorter length each time

D. Cut material for solid headers

(NOTE: On some jobs, another type of header may be specified.)

1. Determine lengths needed
2. Determine number needed for each size opening

   (NOTE: Remember that each header requires two pieces.)

3. Set up saw to cut headers

   (NOTE: Cut the longest headers first. Plan all your cuts so that waste is held to a minimum.)

4. Cut headers from 2 × 12 stock

JOB SHEET #2

5. Repeat entire procedure for each length of header

6. Cut spacers for headers from ½-inch CD plywood

   (NOTE: Three spacers are needed for short headers and more for longer headers. Spacers should be cut slightly less than the width of the header and they should be at least 1 ½-inches wide.)

E. Clean work area and put away tools and materials

WALL AND CEILING FRAMING
UNIT II

JOB SHEET #3 — BUILD CORNERS, Ts, AND HEADERS

I. Tools and materials

   A. Claw hammer

   B. Power handsaw and extension cord

   C. Folding rule or steel tape

   D. Studs

   E. Stock for blocking

   F. 16d box nails

   G. 2×12 header material cut to length

   H. ½-inch plywood for header spacers

II. Procedure

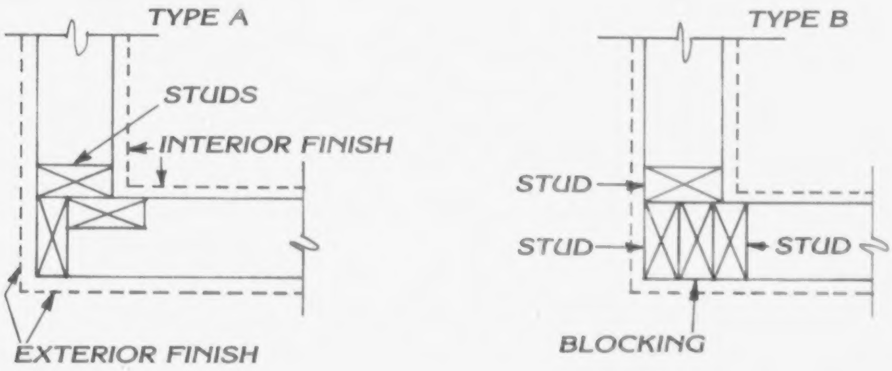
   A. Construct corners

      1. Determine number of corners needed

      2. Select three of the straightest studs for each corner

      3. Determine type of corner to use (Figure 29)

FIGURE 29


TYPE A
STUDS
INTERIOR FINISH
EXTERIOR FINISH
TYPE B
STUD
STUD
STUD
BLOCKING

JOB SHEET 3

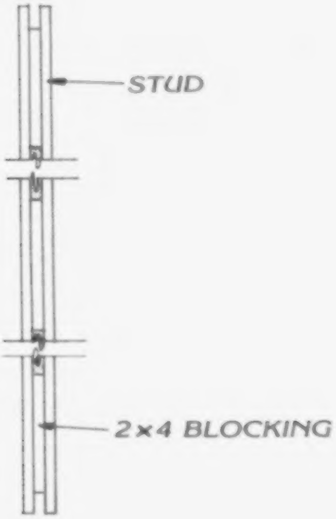
4. Construct Type B corners

   a. Use three blocking pieces 10 to 16 inches long for each corner

      (NOTE: Scrap material may be used for blocking.)

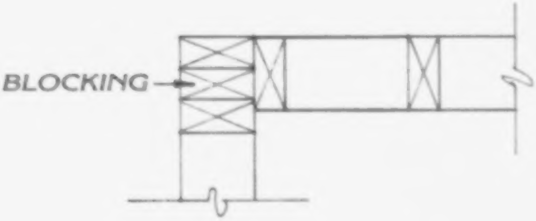
   b. Nail two studs together with blocking between (Figure 30)

FIGURE 30



   c. Attach third stud to end of wall and nail to corner as walls are erected (Figure 31)

FIGURE 31

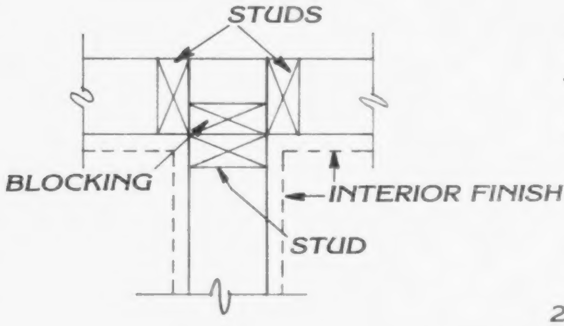


JOB SHEET #3

B. Construct partition Ts

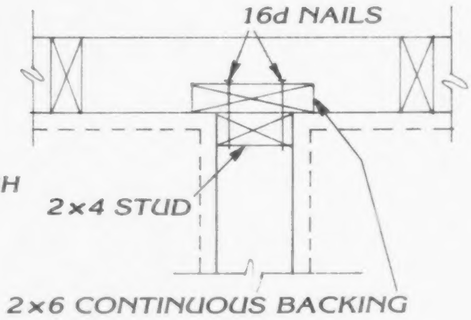
1. Determine the number of Ts needed
2. Determine which type of T to use (Figures 32-34)

FIGURE 32


STUDS
BLOCKING
INTERIOR FINISH
STUD

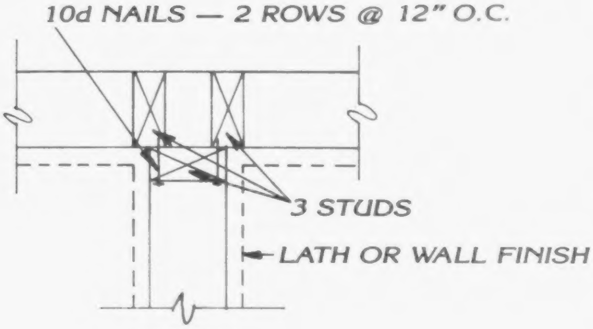
TYPE A

FIGURE 33


16d NAILS
2×4 STUD
2×6 CONTINUOUS BACKING

TYPE B

FIGURE 34


10d NAILS — 2 ROWS @ 12" O.C.
3 STUDS
LATH OR WALL FINISH

TYPE C

3. Determine material needed for type of T to be completed
4. Construct Type A Ts

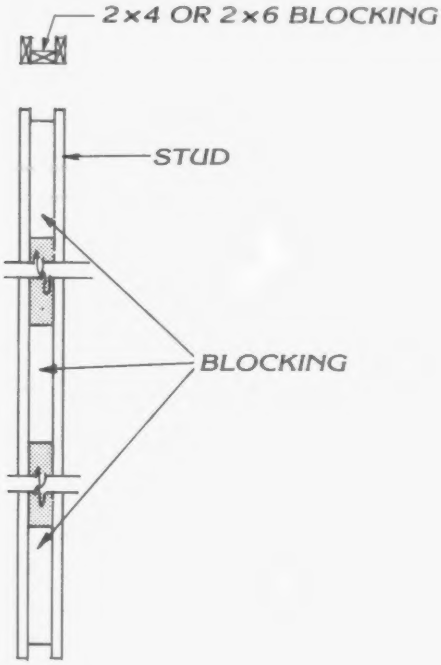
   (NOTE: Type A is preferred by most builders.)

   a. Select three of the straightest studs for each T
   b. Use three blocking pieces 10 to 16 inches long for each T

JOB SHEET 3

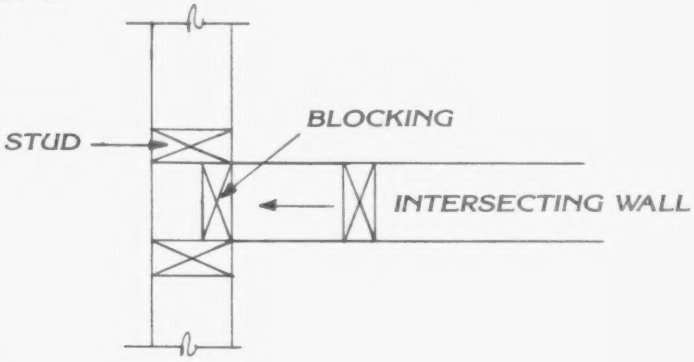
c. Nail two studs together with blocking between (Figure 35)

FIGURE 35


2×4 OR 2×6 BLOCKING
STUD
BLOCKING

d. Attach third stud to the end of the intersecting wall and nail to blocking as walls are erected (Figure 36)

FIGURE 36

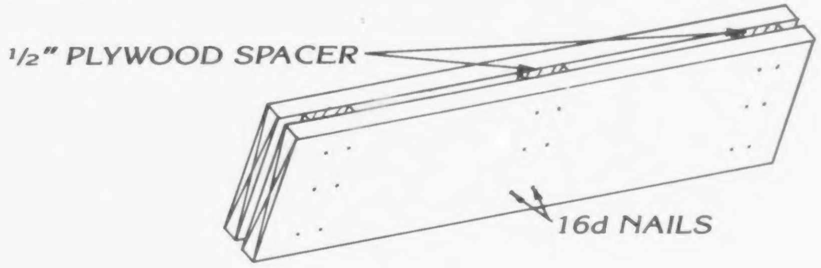

STUD
BLOCKING
INTERSECTING WALL

JOB SHEET #3

C. Construct solid headers

1. Arrange plywood spacers 16 to 24 inches apart along one 2×12
2. Place second 2×12 on top of spacers with edges and ends even with first 2×12
3. Hold second 2×12 in place and drive nails into it (Figure 37)

FIGURE 37



D. Cut rough sills

1. Determine lengths of rough sills by subtracting thickness of two studs from each window header length
2. Cut one rough sill for each window

   (NOTE: Some very heavy windows may require an extra sill.)

E. Clean work area and put away tools and materials

WALL AND CEILING FRAMING
UNIT II

JOB SHEET #4 — CONSTRUCT WALL SECTIONS FOR A SINGLE-STORY STRUCTURE

I. Tools and materials

   A. Folding rule or steel tape

   B. Claw hammer

   C. Framing square

   D. Power handsaw and extension cord

   E. 4-foot level

   F. 100-foot tape marked 16 inches on center

   G. 16d and 8d nails

   H. Regular studs

   I. Corners

   J. Ts for partitions

   K. Headers

   L. 16-foot-long plate material

   M. Cripple studs

   N. Trimmer studs

   O. Brace material, 12-foot-long 1×4s or 4×8 plywood

II. Procedure

   A. Plan sequence for raising walls

   B. Select material from sixteen-foot stock for plates

   (NOTE: Crooked material may be used for soleplates since they can easily be straightened. Straight stock should be saved for top plates.)

JOB SHEET #4

C. Cut soleplate and top plate for first wall to length and tack to floor side by side with ends flush (Figure 38)

(NOTE: Some carpenters prefer to tack plates together face to face and lay out studs on the edges of the plates.)

FIGURE 38

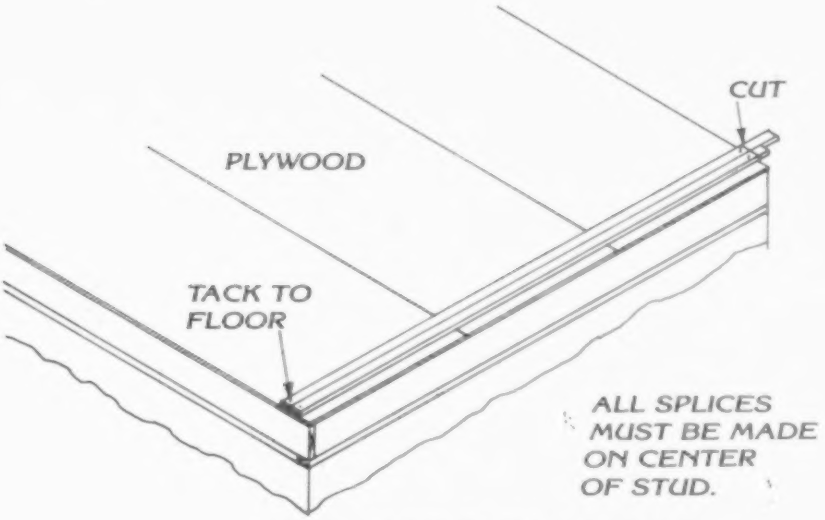

CUT
PLYWOOD
TACK TO FLOOR
ALL SPLICES MUST BE MADE ON CENTER OF STUD.

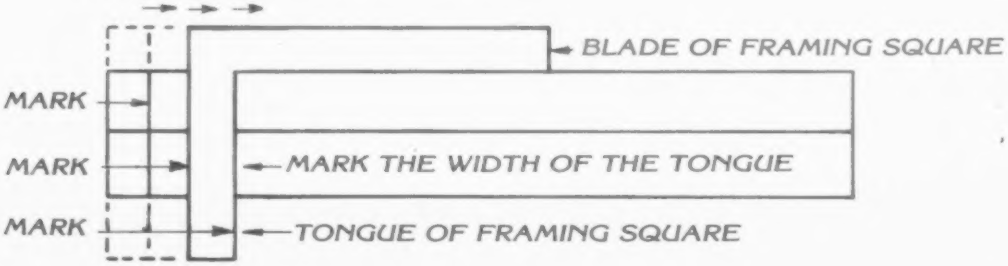
PLATE LAID OUT ON SUBFLOOR

D. Lay off stud locations on plates, side walls first

(NOTE: Lay off all walls from left to right.)

1. Mark plates for corner post (Figure 39)

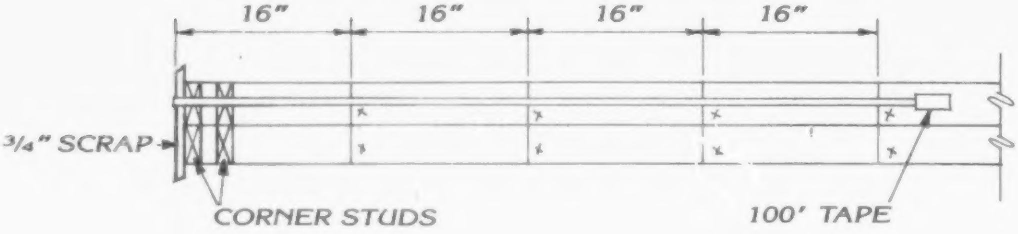
FIGURE 39


BLADE OF FRAMING SQUARE
MARK
MARK
MARK THE WIDTH OF THE TONGUE
MARK
TONGUE OF FRAMING SQUARE

JOB SHEET #4

2. Use 100-foot tape to lay off all stud locations
    a. Place scrap of 3/4-inch material at left end of plates
    b. Hook end of tape over scrap piece and make a mark on the plates at stud intervals along tape
    c. Place a small "X" at the right of each mark (Figure 40)

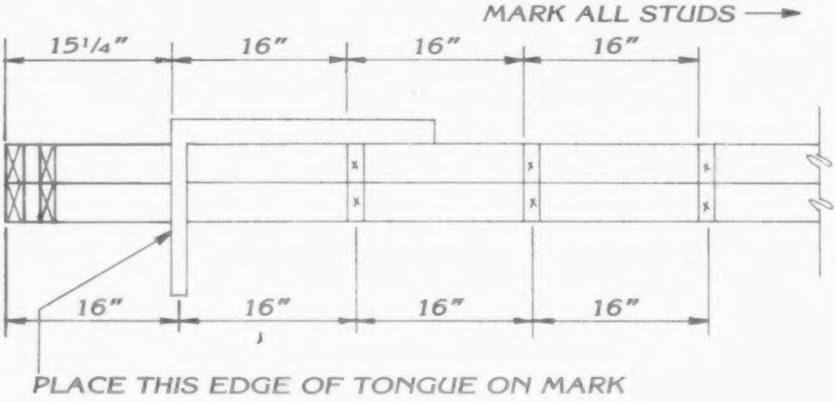
FIGURE 40


16"
16"
16"
16"
3/4" SCRAP
CORNER STUDS
100' TAPE

    d. Use framing square to mark stud locations across both plates (Figure 41)

    (NOTE: Splices in the plate must fall at center of stud.)

FIGURE 41

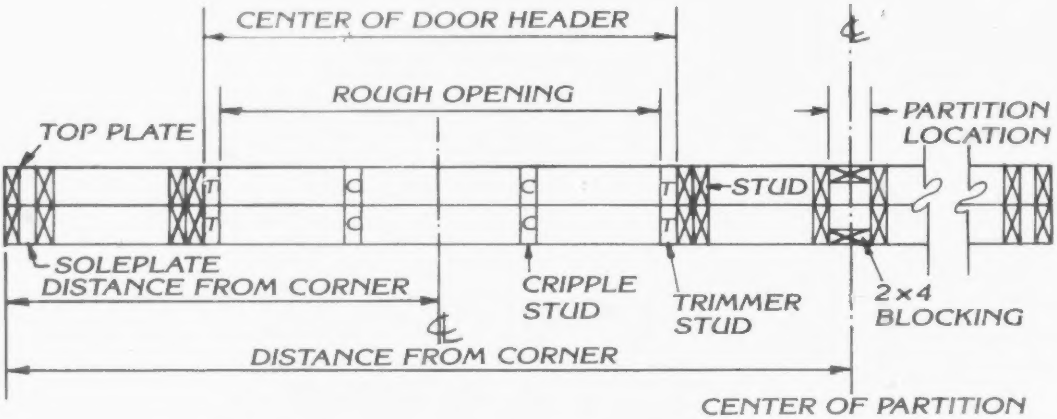

MARK ALL STUDS →
15 1/4"
16"
16"
16"
16"
16"
16"
16"
PLACE THIS EDGE OF TONGUE ON MARK

JOB SHEET #4

3. Locate center of openings and lay off trimmer stud locations
    a. Determine distance from end of plate to center of opening from plan
    b. Measure required distance and mark on plate
    c. Measure and mark one-half of header length on each side of center of opening

        (NOTE: This locates outside of each trimmer stud.)
    d. Mark trimmer stud locations with a "T" and cripple studs with a "C"
4. Locate and mark positions on the plates with the style partition T you plan to use (Figure 42)

FIGURE 42


CENTER OF DOOR HEADER
ROUGH OPENING
TOP PLATE
PARTITION LOCATION
STUD
T
C
SOLEPLATE
DISTANCE FROM CORNER
CRIPPLE STUD
TRIMMER STUD
2×4 BLOCKING
DISTANCE FROM CORNER
CENTER OF PARTITION

5. Lay off other walls, using same procedure

    (NOTE: Remember that end walls will fit between side walls; therefore, the plates will be shorter than the outside wall dimensions by the width of two plates.)
6. Remove nails from plates

E. Assemble wall sections
1. Turn plates on edge with marks facing each other

    (NOTE: Build wall with inside of wall facing down.)
2. Place soleplate at edge of floor
3. Move top plate approximately nine feet toward center of structure
4. Lay studs at each "X" mark

    (NOTE: If studs are crooked, turn so that crown is up.)

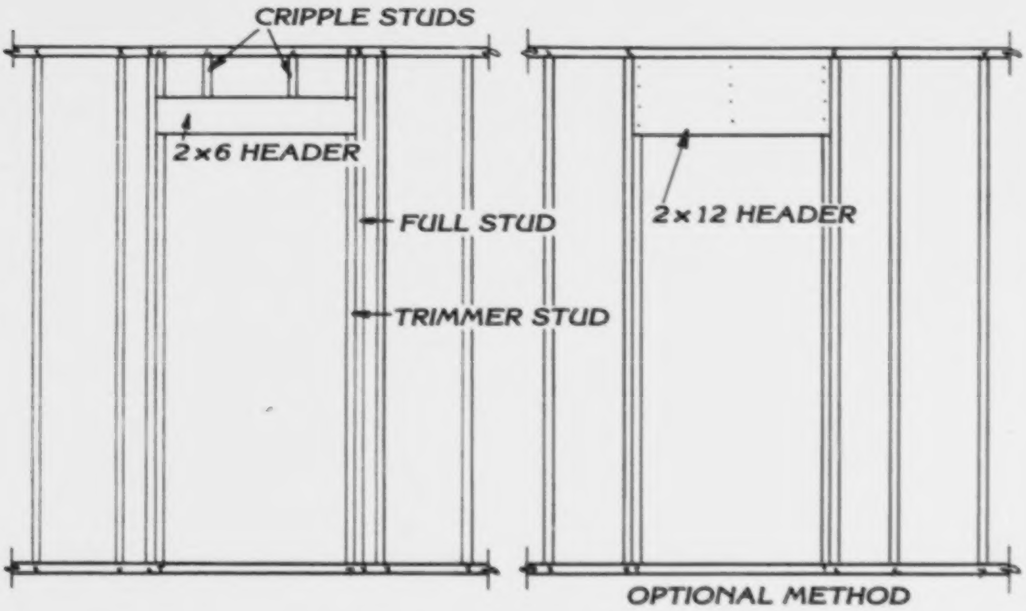
JOB SHEET #4

5. Place appropriate size headers in place

6. Place trimmer studs at each spot marked with a "T"

   (NOTE: Trimmer studs and headers may be assembled prior to wall assembly; see Figure 43)

FIGURE 43


CRIPPLE STUDS
2×6 HEADER
FULL STUD
TRIMMER STUD
2×12 HEADER
OPTIONAL METHOD

7. Place rough sills and cripple studs where openings are located

F. Nail framework together

1. Drive two 16d nails through the plate into end of each 2×4 stud; use three nails for 2×6 studs

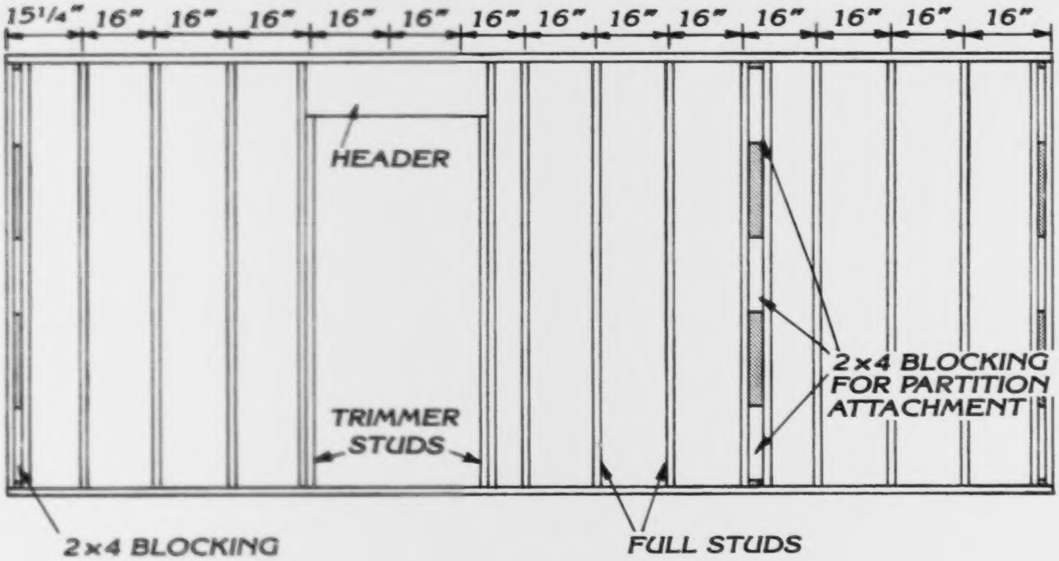
2. Install headers and trimmers or opening assemblies, making sure that openings are framed square and level

3. Nail cripple studs in place and install rough sills where needed

JOB SHEET #4

4. Finish nailing framework together (Figure 44)

FIGURE 44


15¼"
16"
16"
16"
16"
16"
16"
16"
16"
16"
16"
16"
16"
16"
HEADER
TRIMMER STUDS
2×4 BLOCKING FOR PARTITION ATTACHMENT
2×4 BLOCKING
FULL STUDS

(NOTE: Soleplates at door openings may be cut out at any convenient time during the layout or construction process.)

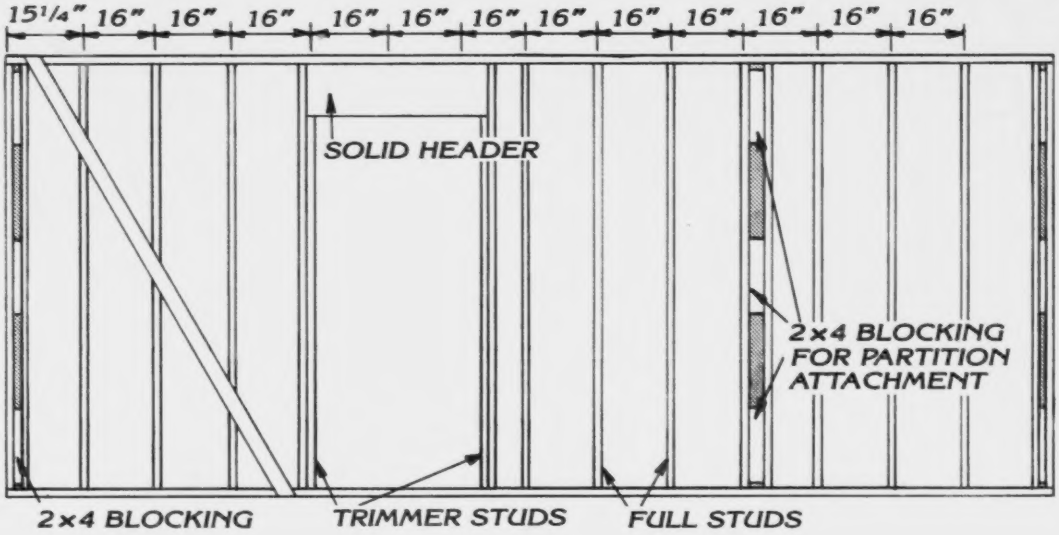
G. Install permanent bracing

(NOTE: Diagonal lumber or plywood corners do not need any additional bracing).

1. Lay 1×4×12-foot bracing against studs with left end near top of corner stud and right end against soleplate
2. Mark each side of brace on each stud
3. Saw out sections for brace on each stud
4. Temporarily nail top of brace to corner
5. Square framework
6. Temporarily nail brace to soleplate (See Figure 45)

JOB SHEET #4

FIGURE 45


15¼"
16"
16"
16"
16"
16"
16"
16"
16"
16"
16"
16"
16"
SOLID HEADER
2×4 BLOCKING FOR PARTITION ATTACHMENT
2×4 BLOCKING
TRIMMER STUDS
FULL STUDS

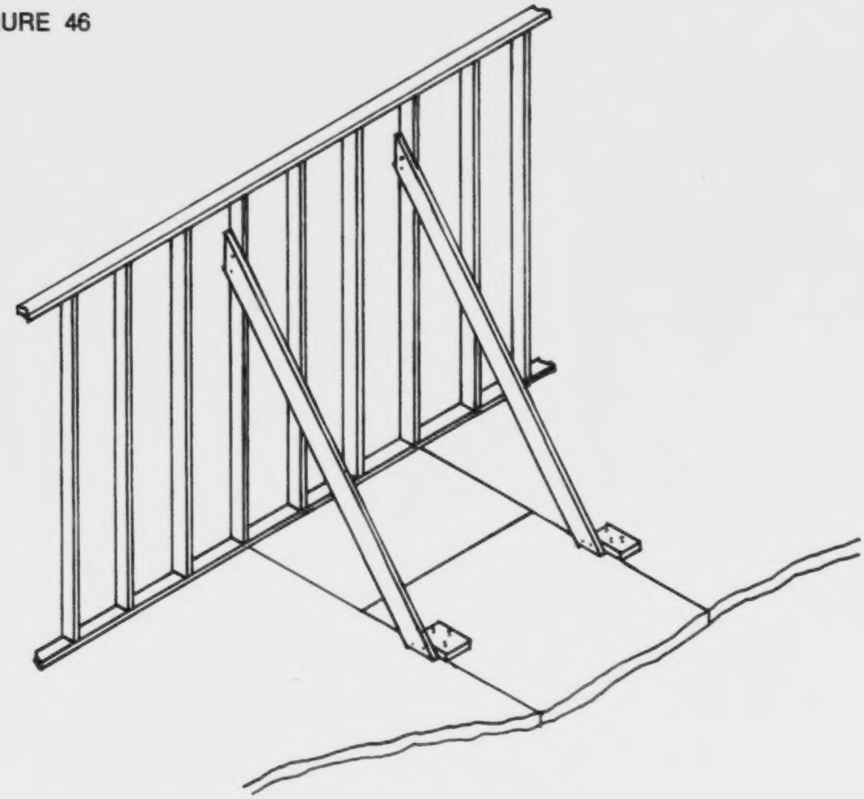
H. Raise wall section and nail in place

1. On wood floors, use two 16d nails in every other floor joist
2. On concrete slabs, use concrete nails, powder-actuated tool and pins, or preset anchor bolts
3. Attach temporary bracing (See Figure 46)

   (NOTE: Be sure bracing does not protrude through exterior of wall.)

JOB SHEET #4

FIGURE 46



I. Construct remainder of wall section following same procedure; raise and nail in place

J. Replumb corners

K. Nail corners together using 16d nails

L. Check that corners are plumb and square; nail bracing in place

   1. Completely drive nails in top plate and soleplate

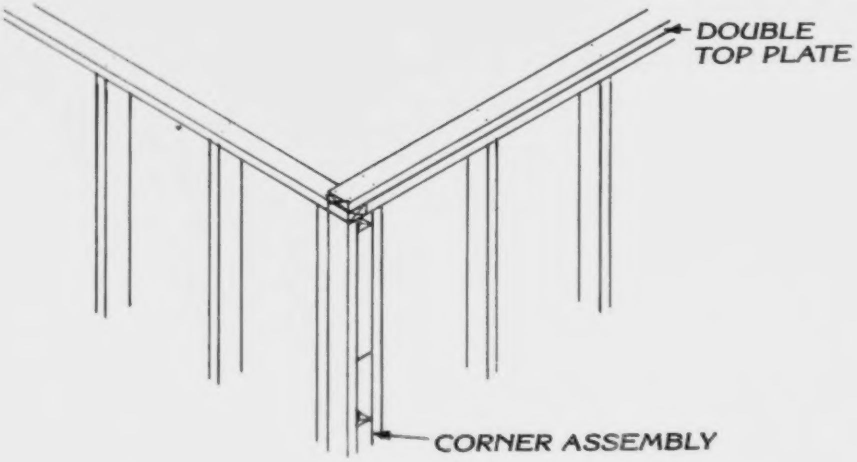
   2. Drive nail through bracing into each stud

JOB SHEET #4

M. Lay out double top plate

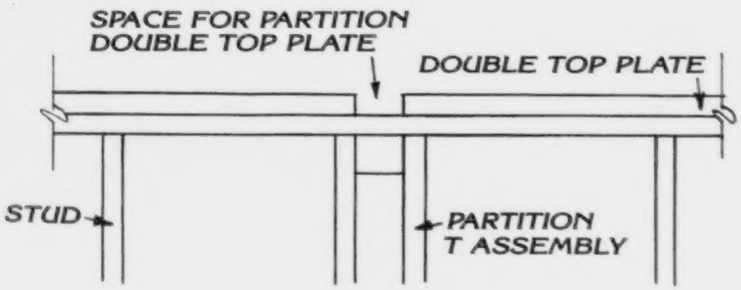
1. Begin at corner and lay out double top plate along end wall first (Figure 47)

FIGURE 47


DOUBLE TOP PLATE
CORNER ASSEMBLY

2. Cut double top plate on exterior walls to accept double top plate on partitions (Figure 48)

FIGURE 48


SPACE FOR PARTITION DOUBLE TOP PLATE
DOUBLE TOP PLATE
STUD
PARTITION T ASSEMBLY

JOB SHEET #4

N. Install double top plate (Figure 49a and 49b)

1. Drive two 16d nails at the end of each double top plate section
2. Drive one 16d nail on each side of stud locations on opposite sides of double top plate

FIGURE 49a

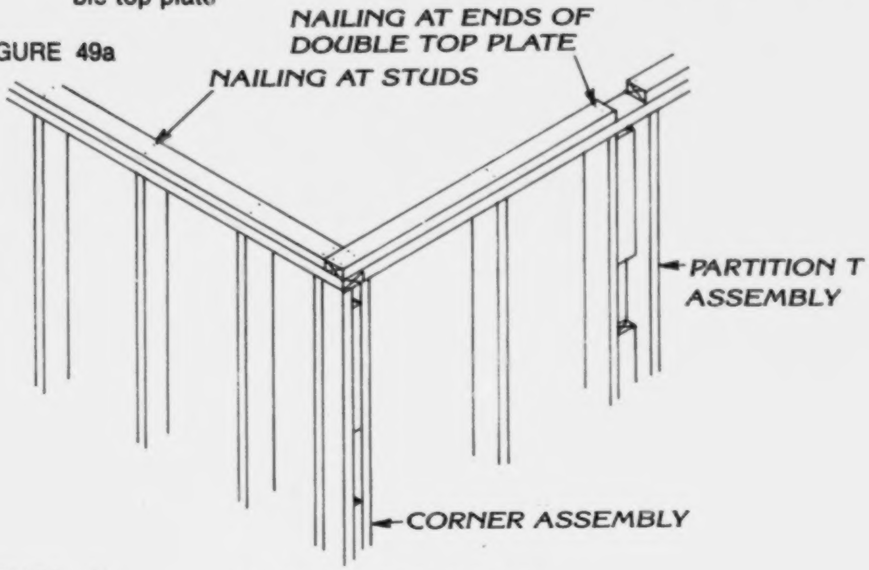
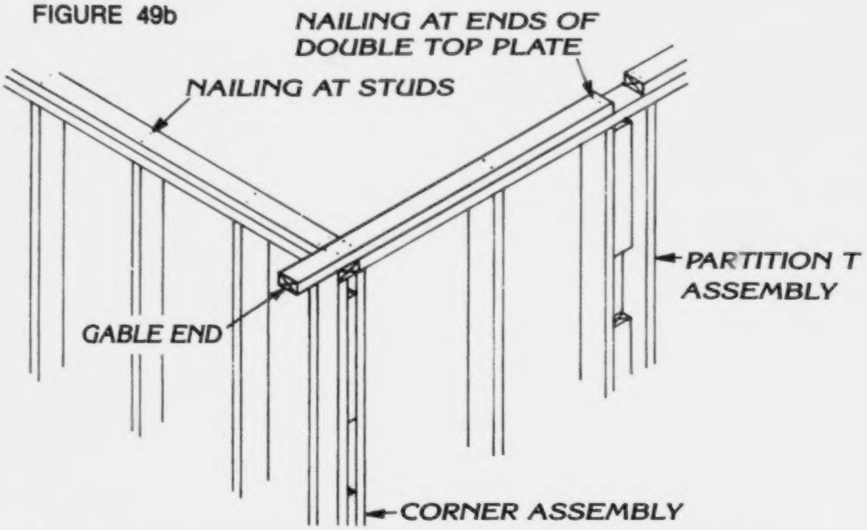

NAILING AT ENDS OF DOUBLE TOP PLATE
NAILING AT STUDS
PARTITION T ASSEMBLY
CORNER ASSEMBLY

FIGURE 49b


NAILING AT ENDS OF DOUBLE TOP PLATE
NAILING AT STUDS
PARTITION T ASSEMBLY
GABLE END
CORNER ASSEMBLY

O. Construct and install interior walls following same procedures

P. Install interior double top plates and tie to exterior walls

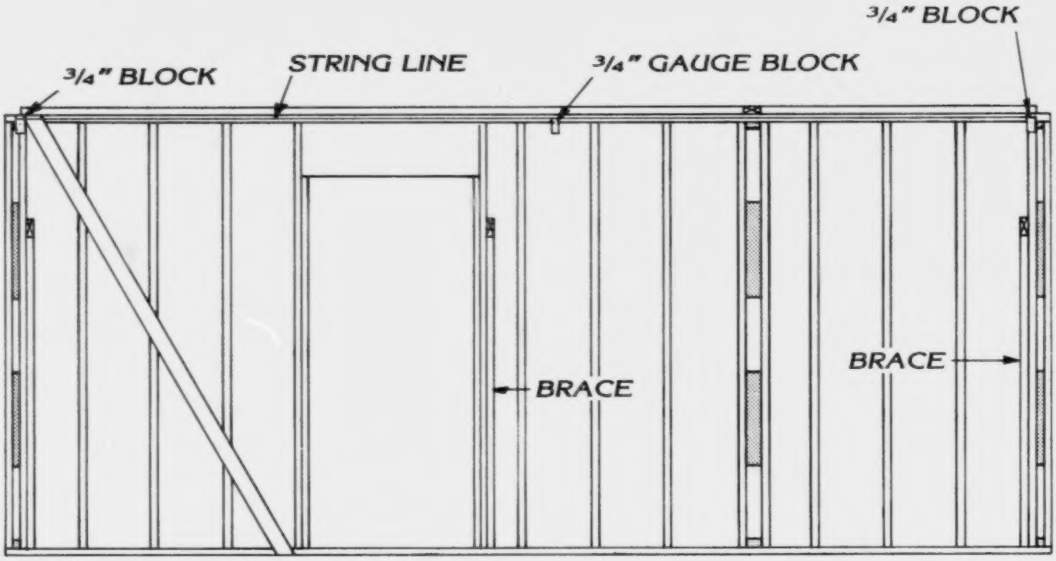
Q. Straighten walls and adjust bracing (See Figure 50)

1. Nail ¾-inch block on each corner at top of walls

JOB SHEET #4

2. String line from one corner to opposite corner
3. Stretch line very tight so there is no sag
4. Use ¾-inch gauge block to check wall line
5. Adjust bracing as you check the wall

FIGURE 50


¾" BLOCK
STRING LINE
¾" GAUGE BLOCK
¾" BLOCK
BRACE
BRACE

R. Clean work area and put away tools and materials

WALL AND CEILING FRAMING
UNIT II

JOB SHEET #5 — LAY OUT AND INSTALL CEILING JOISTS

I. Tools and materials

  A. 100-foot tape with markings at 16-inch centers

  B. Folding rule or steel tape

  C. Claw hammer

  D. Power handsaw and extension cord

  E. Framing square

  F. Joists, lengths and sizes as specified

  G. 16d box nails

II. Procedure

(NOTE: Ceiling joists are normally installed after the walls are erected and before the roof is framed. However, in laying out and installing ceiling joists, the roof design must be considered. Your instructor may choose to teach this procedure after you have studied Unit III, "Roof Framing.")

  A. Lay out joist locations on double top plate

    1. For a gable roof

      a. Determine the direction joists will run (usually the width of the structure)

      b. Locate the outside of the first joist flush with the outside corner of the double top plate

      (NOTE: Allowances must be considered for masonry construction.)

      c. Hold the zero end of the 100-foot tape 3/4-inch past the inside of the end double plate and proceed to mark sixteen-inch intervals on face of the plate, moving from left to right

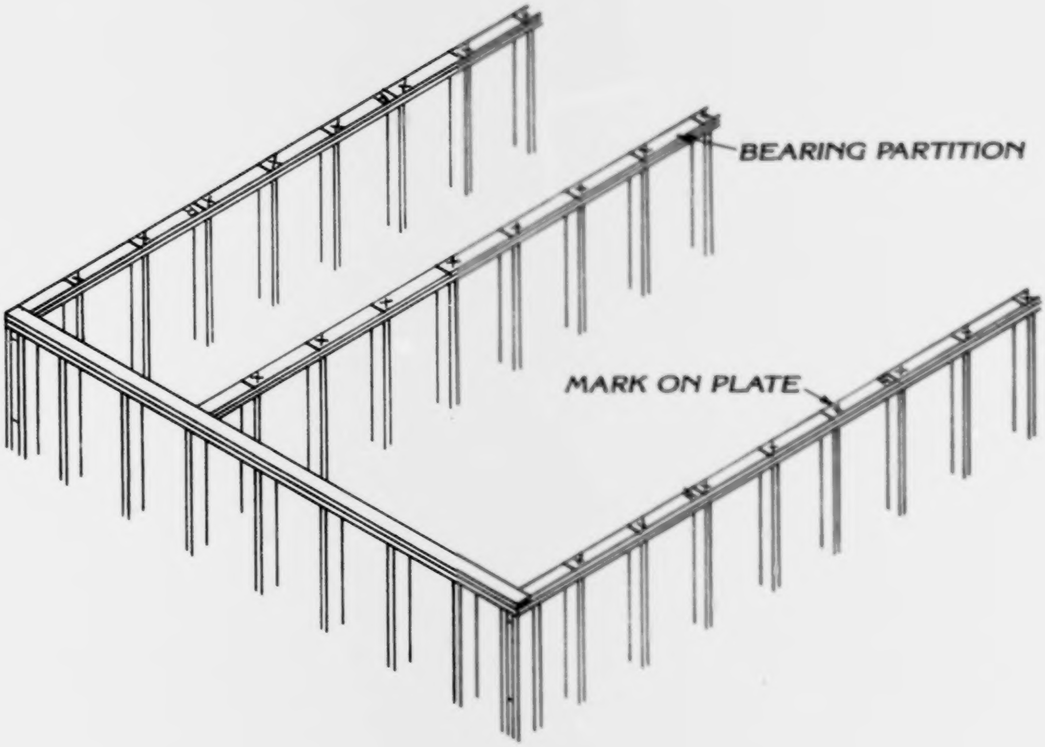
      d. Place an "X" to the right of each mark for joist and an "R" on the left of every third mark for rafters set on two-foot centers

      (NOTE: The "X" designates the side of the mark on which joist is placed. The "R" designates the side of the mark on which the rafter is placed.)

JOB SHEET #5

e. Repeat steps b through d on the opposite wall or bearing partition, reversing the procedure of measurement, going from right to left (Figure 51)

FIGURE 51



2. For a hip roof
   a. Determine the direction joists will run (usually the width of the structure)
   b. Determine length of run and transfer this measurement to the double top plate
   c. Hold the zero end of the 100-foot tape ¾-inch past the first joist location and mark sixteen-inch intervals on the plate, moving from left to right
   d. Place an "X" to the right of each mark

      (NOTE: The "X" designates the side of the mark on which the joist is placed.)

JOB SHEET #5

e. Repeat steps c and d on the opposite wall or bearing partition, reversing the procedure of measurement, going from right to left

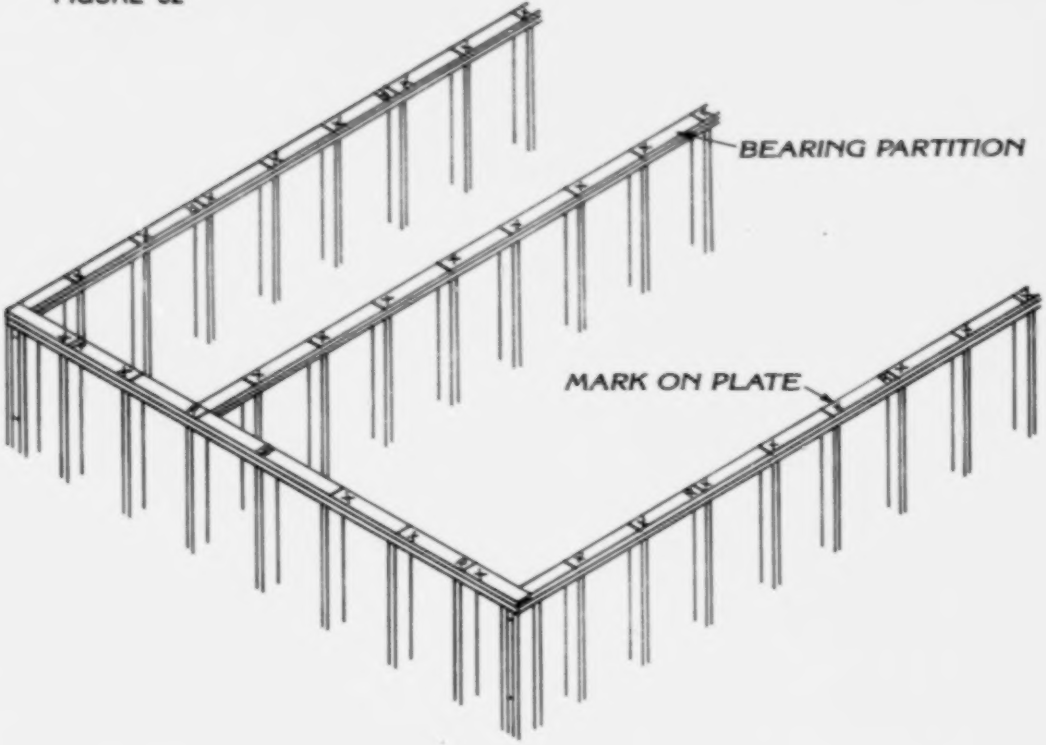
f. Establish center of end wall and mark

g. Hold zero end of the tape ¾-inch past the center mark and mark sixteen-inch intervals on the plate, moving from left to right

h. Place an "X" to the right of each mark

i. Repeat steps g and h on opposite end, reversing the procedure of measurement, going from right to left (Figure 52)

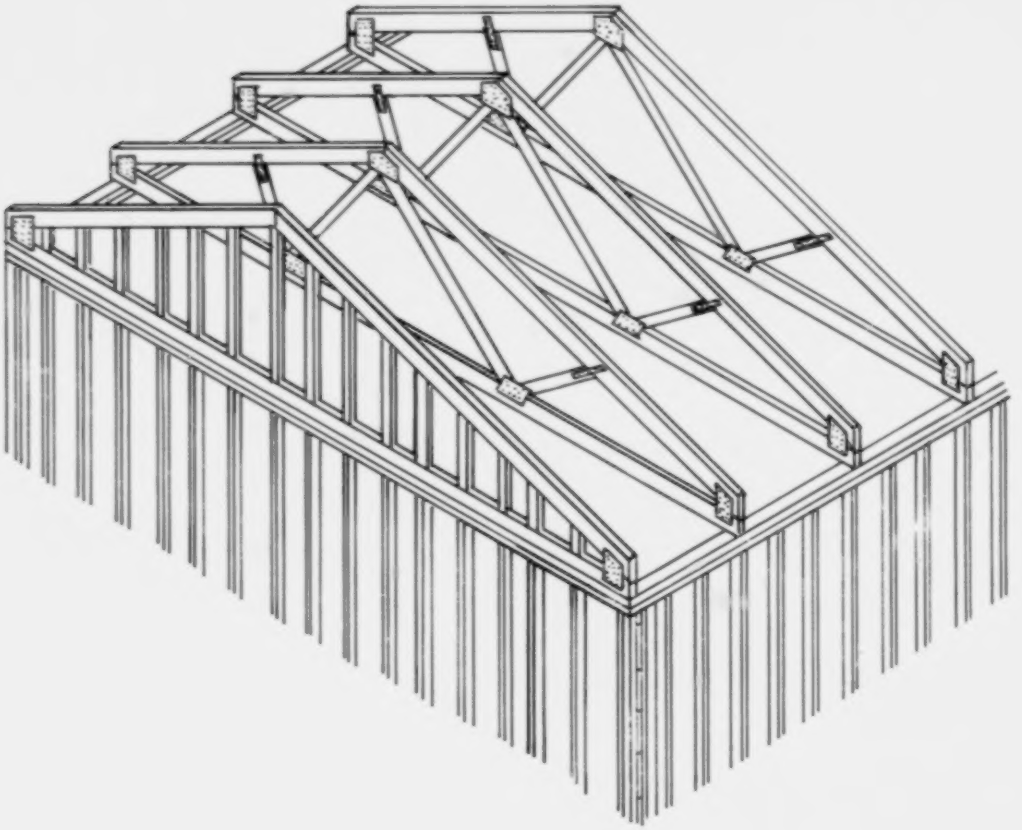
FIGURE 52



JOB SHEET #5

(NOTE: When roof trusses are used, the ceiling joists are eliminated. Roof trusses can usually be spaced on 2-foot centers; see Figure 53.)

FIGURE 53



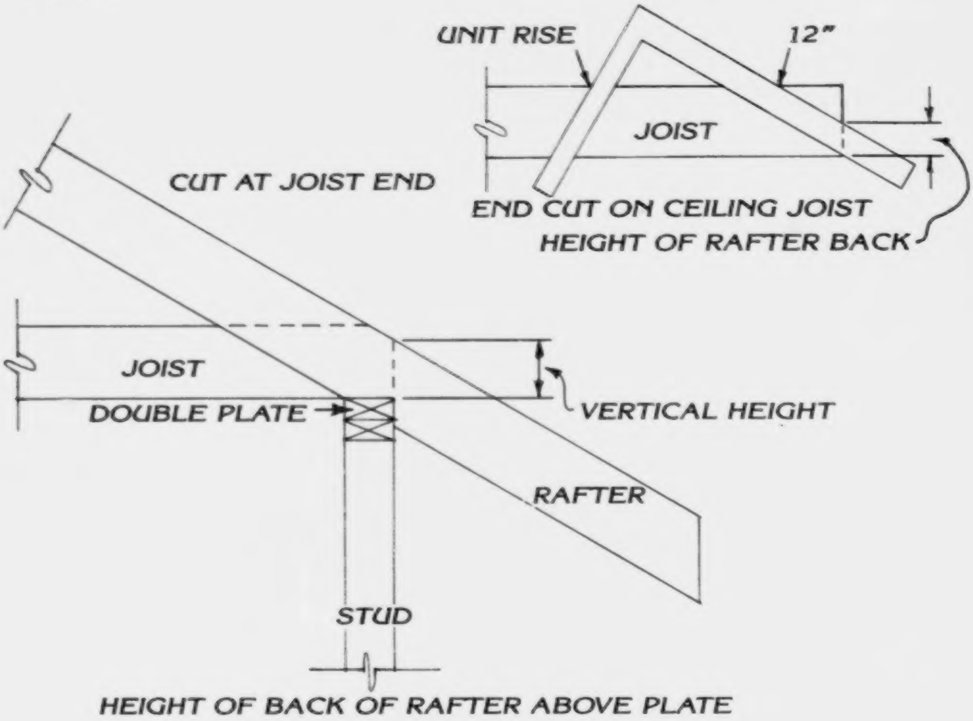
(NOTE: In the above illustration, alternate trusses have been omitted for the sake of clarity.)

B. Install ceiling joists

1. Cut joist ends to the pitch of the roof (See Figure 54)

JOB SHEET #5

FIGURE 54

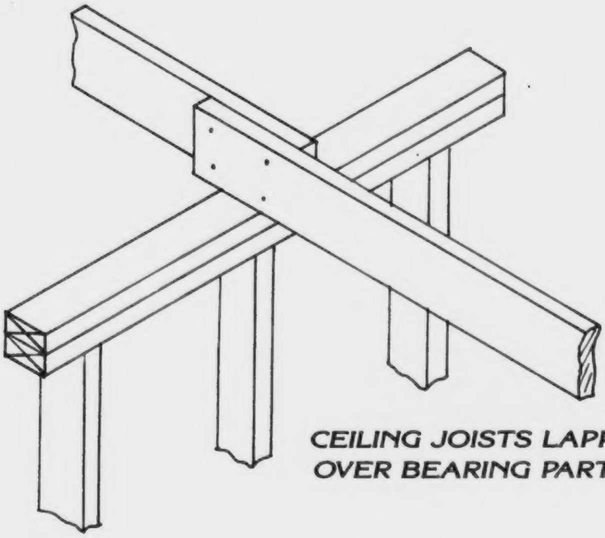

UNIT RISE
12"
JOIST
CUT AT JOIST END
END CUT ON CEILING JOIST
HEIGHT OF RAFTER BACK
JOIST
DOUBLE PLATE
VERTICAL HEIGHT
RAFTER
STUD
HEIGHT OF BACK OF RAFTER ABOVE PLATE

2. Place one joist, crown up, on each mark that was made on the plate
3. Splice joists on bearing walls (See Figures 55 and 56)

   (NOTE: There should be a minimum overlap of 6 inches.)

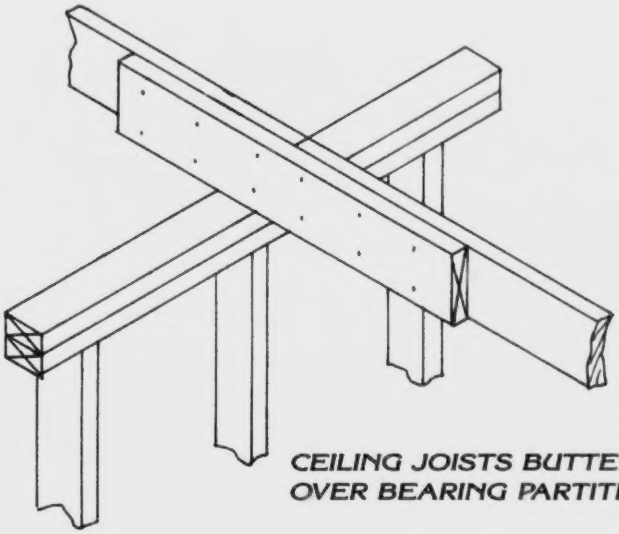
JOB SHEET #5

FIGURE 55



CEILING JOISTS LAPPED OVER BEARING PARTITION

FIGURE 56

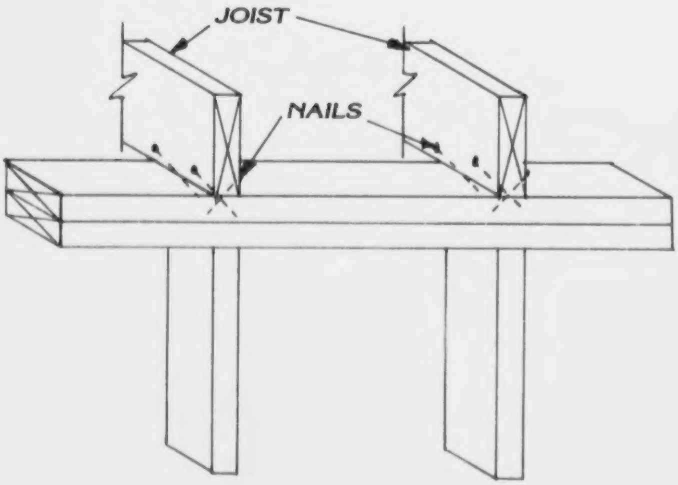


CEILING JOISTS BUTTED OVER BEARING PARTITION

JOB SHEET #5

4. Toenail joists to plate with three 16d box nails (Figure 57)

FIGURE 57



C. Clean work area and put away tools and materials

WALL AND CEILING FRAMING
UNIT II

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with wall and ceiling framing to their correct definitions. Write the correct numbers in the blanks.

_____a. Top and sides of a door or window frame that contacts the door or window sash; consists of a head jamb and side jambs

_____b. Lowest horizontal member of a wall or partition to which the studs are nailed; rests on the rough floor

_____c. Horizontal structural member that supports the load over an opening, such as a window or door

_____d. Triangular portion of exterior wall above the eaves at the end at a structure

_____e. Partition wall that supports the structure above

_____f. Wood block used as filler piece and support between framing members

_____g. Any part of a framing stud that is cut less than full size, as over a door or window or under a window opening

_____h. Main vertical framing member in walls and partitions

_____i. Upper horizontal structural member of a wall used to carry the rafters or trusses of a roof

_____j. Top plate made of two members to allow better stiffening of the wall and for tying together splices, corners, and partitions that are at right angles to a wall

1. Header
2. Top plate
3. Blocking (spacer)
4. Stud
5. Bearing wall
6. Rough opening
7. Gable
8. Double top plate
9. Soleplate
10. Partition
11. Rough sill
12. Trimmer
13. Bearing partition
14. Jamb
15. Cripple stud

TEST

_____k. Opening in framing formed by framing members, such as for windows and doors

_____l. Wall that subdivides space within a building

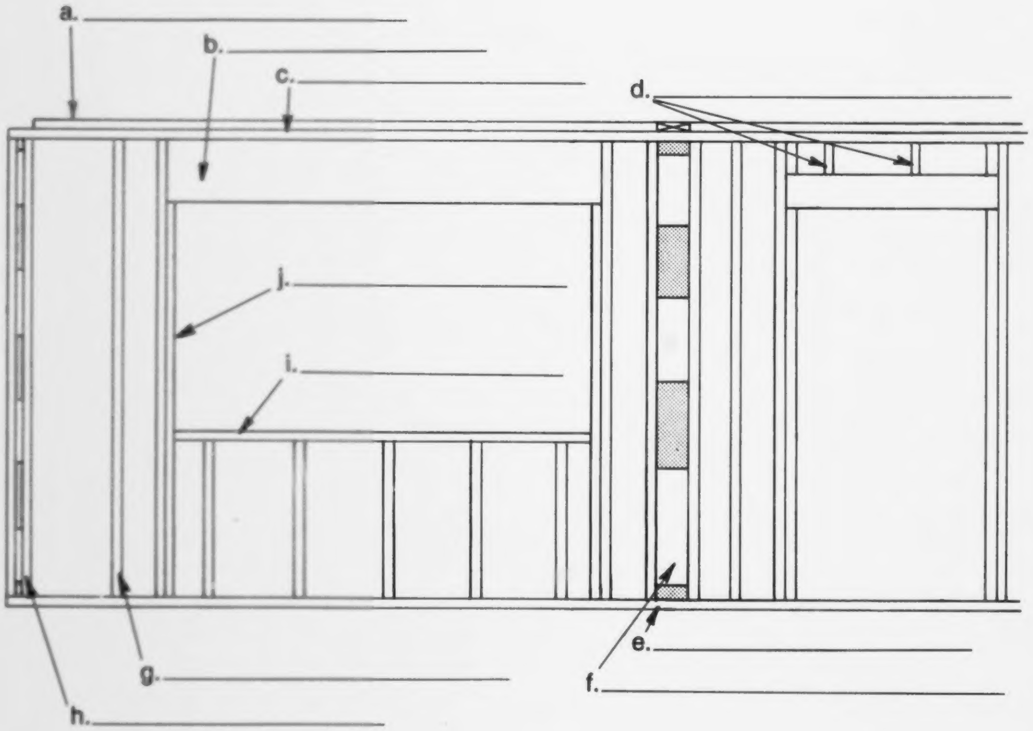
_____m. Vertical framing member that forms the sides of rough openings for doors and windows and on which the header rests

_____n. Wall that supports the floors and roof directly above it in addition to its own weight

_____o. Lower framing member attached to the top of the bottom cripple studs to form the base of a rough opening for a window

2. Identify the framing members in the following illustration. Write the correct names in the blanks.

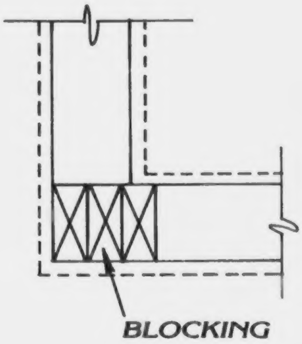
Corner assembly
Cripple studs
Rough sill
Partition wall assembly
Double top plate
Regular stud
Soleplate
Header
Trimmer stud
Top plate



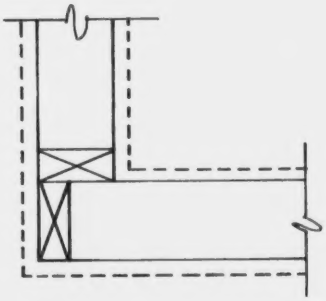
TEST

3. Complete drawings of common methods used to construct outside corners of wall frames. Draw in the missing member in each illustration below.

   a. Constructed with three full studs and blocking

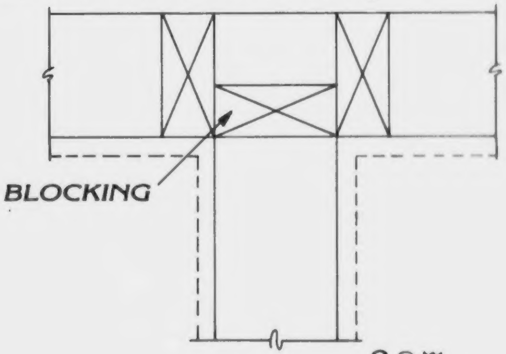


   b. Constructed with three full studs (no blocking)



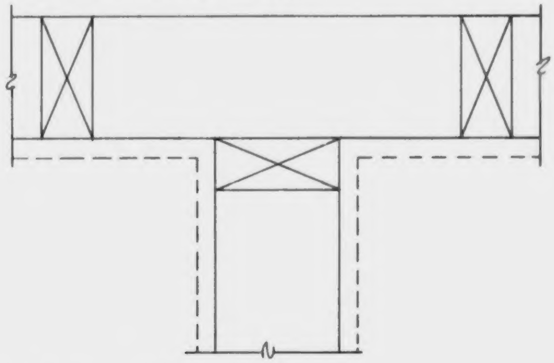
4. Complete drawings of common methods used to construct partition Ts. Draw in the missing member in each of the following illustrations.

   a. Constructed with three studs and blocking

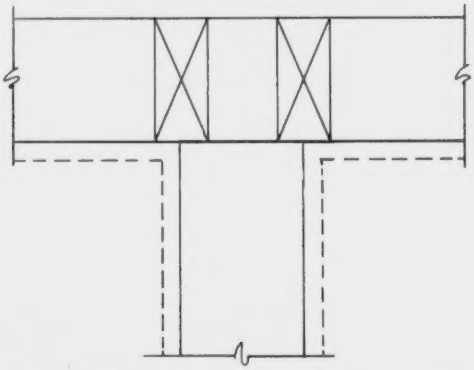


TEST

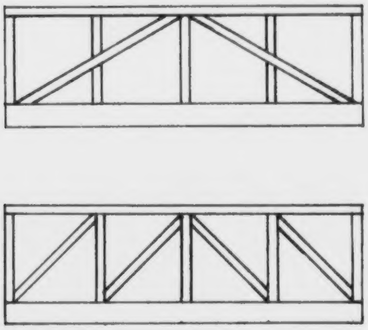
b. Constructed with a continuous backer

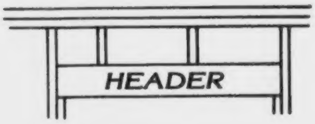


c. Constructed with three studs (no blocking)



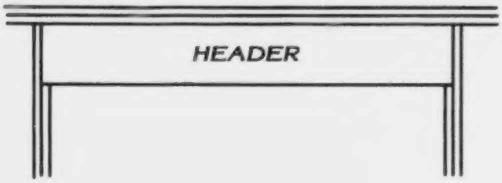
5. Label the types of headers illustrated below. Write the correct names in the blanks.

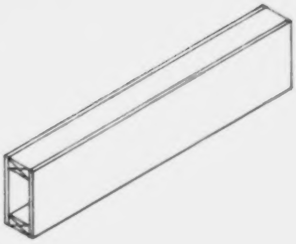




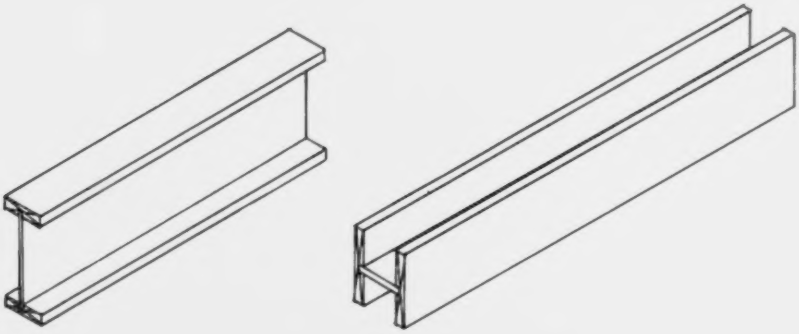
a. ______________________________ b. ______________________________

TEST





c. ______________________ d. ______________________



e. ______________________

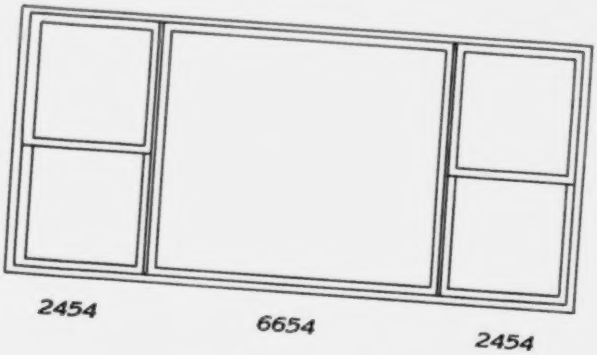
6. Compute the length of a regular stud for a finished ceiling height of 8′-½″ on a conventional wood floor with ½-inch drywall ceiling.

Regular stud length______________________

TEST

7. Compute rough opening (R.O.) dimensions for the combination window units illustrated.

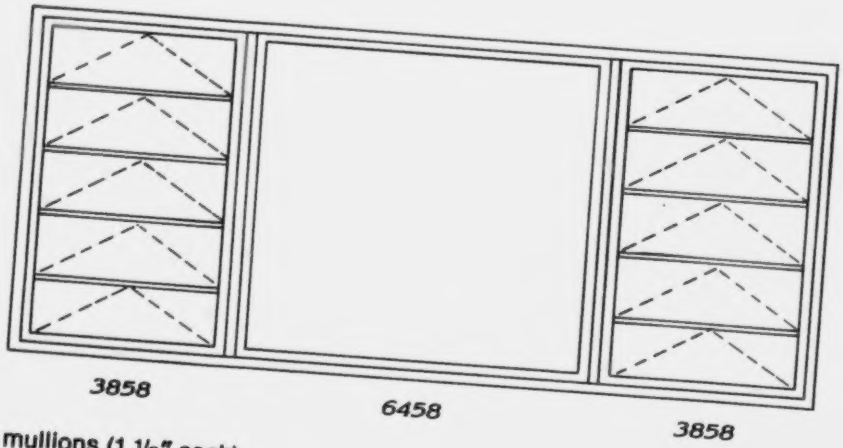
   a. Double hung and fixed


2454
6654
2454

2 mullions (1 1/4" each)

Total rough opening ______________________________

b. Awning and fixed


3858
6458
3858

2 mullions (1 1/2" each)

Total rough opening ______________________________

TEST

8. Compute rough opening (R.O.) dimensions for the doors listed below.
   a. 2′ –8″ × 6′ –8″

      Actual rough opening size ______________________________

   b. 3′ –0″ × 6′ –8″

      Actual rough opening size ______________________________

   c. 3′ –6″ × 7′ –0″

      Actual rough opening size ______________________________

9. Compute the length of trimmers for a standard 6′ –8″ door opening on a slab floor. Show your work.

   Length of trimmers ______________________________

10. Compute the length of the headers for a window 2′ –8″ wide by 4′ –0″ high.

    Length of headers ______________________________

TEST

11. Select from the following list construction details that should be added during wall framing. Write an "X" in the blank before each correct answer.

_____a. Backing for towel bars

_____b. Framing for pocket-type sliding doors

_____c. Supports for television antennas

_____d. Rough opening for dryer vent

_____e. Backings for various appliances

_____f. Rough opening for air conditioners

_____g. Openings for heating ducts

_____h. Corner blocks for nailing base

_____i. Backing for hanging picture frames

_____j. Backing for plumbing fixtures

_____k. Framing for recessed cabinets and electrical panels

_____l. Rough opening for gas furnace

_____m. Rough openings for air ducts, exhaust fans, and disappearing stair units

_____n. Framing for chimney and fireplace

_____o. Rough openings for stairwells

12. List methods used to brace walls.

a. Permanent bracing

1) ____

2) ____

3) ____

b. Temporary bracing

1) ____

2) ____

TEST

13. Select from the following list pennyweights of nails most often used in framing. Write an "X" in the blank before the four most commonly used sizes.

______a. 4d

______b. 6d

______c. 8d

______d. 10d

______e. 12d

______f. 16d

______g. 20d

______h. 30d

14. Select from the following list considerations to be made before selecting joist size and spacing. Mark an X in the correct blanks.

______a. Joist span

______b. Type of lumber

______c. Type of ceiling finish

______d. Use of attic space

______e. Roof construction

15. Match ceiling joist size to maximum allowable spans.

______a. 2×4 joist 16" OC

______b. 2×6 joist 16" OC

______c. 2×8 joist 16" OC

______d. 2×4 joist 24" OC

______e. 2×6 joist 24" OC

______f. 2×8 joist 24" OC

1. 10'–0"
2. 11'–6"
3. 15'–7"
4. 18'–1"
5. 20'–7"
6. 23'–10"

16. List three methods used to support ceiling joists.

a. ____

b. ____

c. ____

TEST

17. List two methods used to anchor ceiling joists to partition walls.

a. ______________________________

b. ______________________________

18. Estimate materials for ceiling joists.

Calculate number and length of ceiling joist for the buildings described below. Assume that a bearing partition runs the length of each building at the midpoint of its width.

a. Building will be 26′–6″ ×22′–0″

2×4 joists set 16″ OC

Number ____________ Length ____________

b. Building will be 82′–0″ ×20′–6″

2×6 joist set 24″ OC

Number ____________ Length ____________

c. Building will be 124′–6″ ×28′–0″

2×8 joist set 24″ OC

Number ____________ Length ____________

19. Describe two methods used to protect joists from twist and bow.

a. ______________________________

____

____

b. ______________________________

____

____

TEST

20. List four types of finishes used on ceilings.

    a. ____________________

    b. ____________________

    c. ____________________

    d. ____________________

21. Estimate the amount of framing material needed for the floor plan illustrated on the next page. Write the correct amounts of materials in the blanks.

    a. Studs, 16" on center ____________________

    b. Plates ____________________

(NOTE: Test question 22 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

22. Demonstrate the ability to

    a. Lay out wall and partition locations on floor.

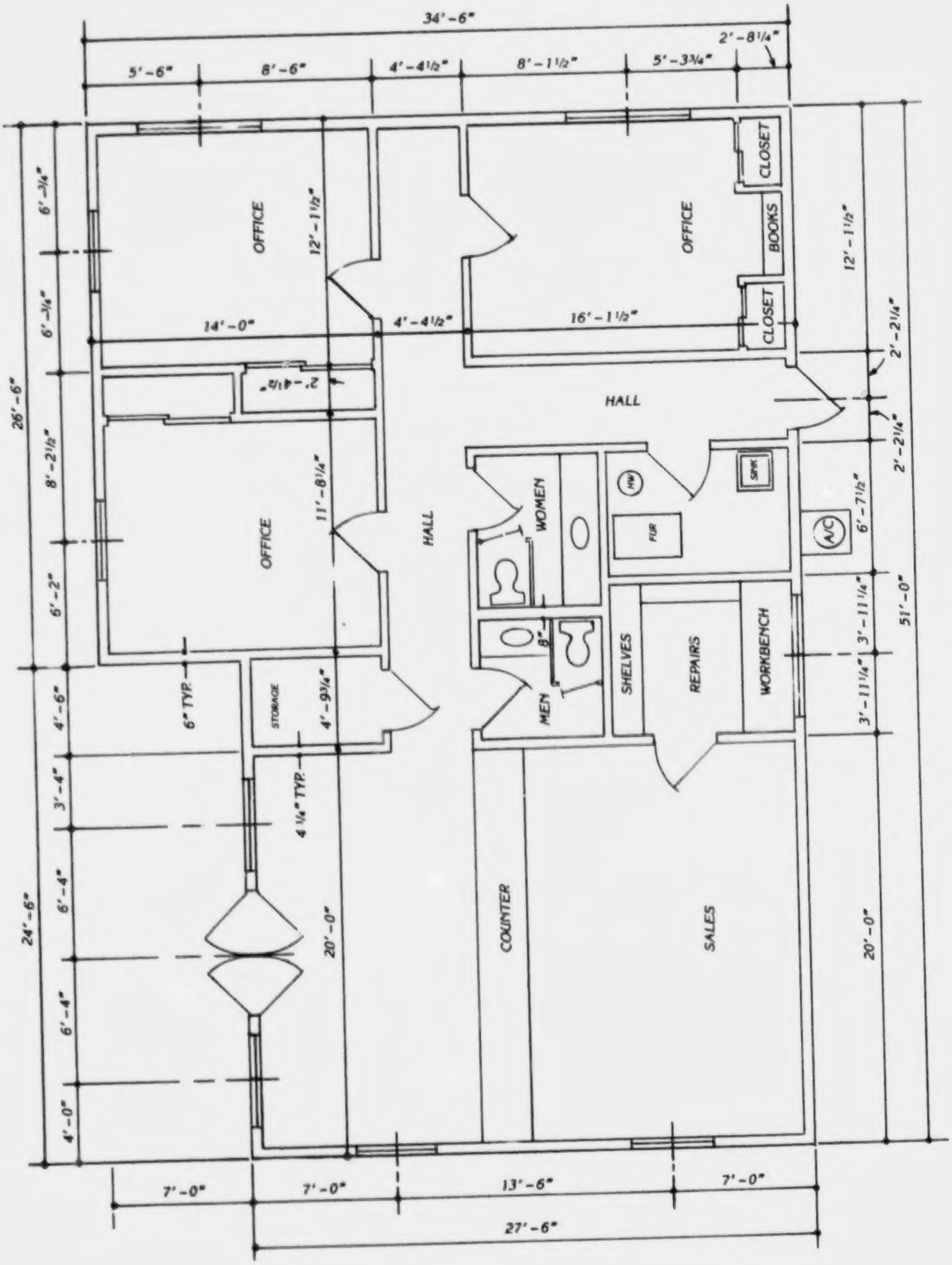
    b. Cut studs, trimmers, cripples, and headers to length.

    c. Build corners, Ts, and headers.

    d. Construct wall sections for a single-story structure.

    e. Lay out and install ceiling joists.

TEST


34'-6"
2'-8¼"
5'-6"
8'-6"
4'-4½"
8'-1½"
5'-3¾"
OFFICE
12'-1½"
OFFICE
CLOSET
BOOKS
CLOSET
14'-0"
4'-4½"
16'-1½"
6'-3¼"
6'-3¼"
26'-6"
8'-2½"
6'-2"
2'-4½"
HALL
OFFICE
11'-8¼"
HALL
WOMEN
HW
SINK
FUR
A/C
12'-1½"
2'-2¼"
2'-2¼"
6'-7½"
51'-0"
3'-11¼"
3'-11¼"
8"
MEN
SHELVES
REPAIRS
WORKBENCH
STORAGE
4'-9¼"
6" TYP.
4'-6"
3'-4"
4¼" TYP.
6'-4"
6'-4"
4'-0"
24'-6"
20'-0"
COUNTER
SALES
20'-0"
7'-0"
7'-0"
13'-6"
7'-0"
27'-6"

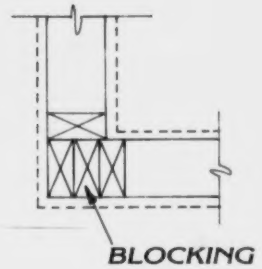
WALL AND CEILING FRAMING
UNIT II

ANSWERS TO TEST

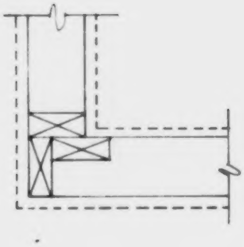
1. a. 14
   b. 9
   c. 1
   d. 7
   e. 13
   f. 3
   g. 15
   h. 4
   i. 2
   j. 8
   k. 6
   l. 10
   m. 12
   n. 5
   o. 11

2. a. Double top plate
   b. Header
   c. Top plate
   d. Cripple studs
   e. Soleplate
   f. Partition wall assembly
   g. Regular stud
   h. Corner assembly
   i. Rough sill
   j. Trimmer stud

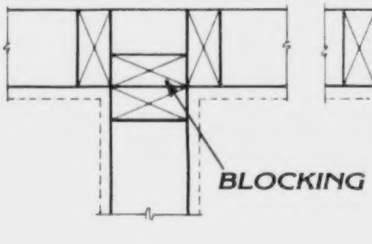
3. a.



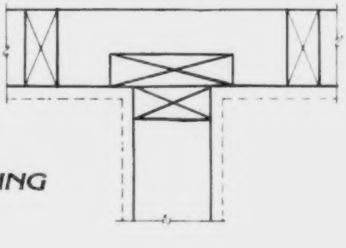
b.



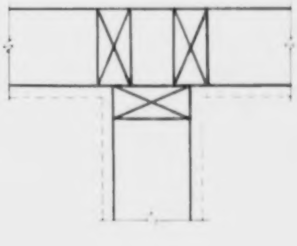
4. a.



b.



c.



5. a. Truss header
   b. Small header with cripples
   c. Solid or full header
   d. Box beam header
   e. I-beam header

6. 7'-9 1/8" or 93 1/8"

ANSWERS TO TEST

7. a. 11′-6½″ × 5′-6″
   b. 14′-1″ × 5′-10″

8. a. 2′-10½″ × 6′-10″
   b. 3′-2½″ × 6′-10″
   c. 3′-8½″ × 7′-2″

9. 6′-8⅝″

10. 3′-1½″

11. a, b, e, g, h, j, k, m, n, o

12. a. Permanent bracing
    1) Plywood sheathing
    2) Let-in corner bracing with 1×4 solid lumber
    3) Metal bracing

    b. Temporary bracing
    1) 2×4 wall brace
    2) Adjustable, metal wall brace

13. b, c, f, g

14. a, c, d

15. a. 2
    b. 4
    c. 6
    d. 1
    e. 3
    f. 5

16. Answer should include three of the following.

    a. Metal joist hangers
    b. Supported by beam (above or below)
    c. Beam with a ledger
    d. Wall supported

ANSWERS TO TEST

17. Answer should include two of the following.

    a. Nailing strip and blocking
    b. Blocking only
    c. Solid blocking with double joist

18. a. 42, 12′
    b. 84, 12′
    c. 126, 16′

19. Answer should include the following.

    a. Use 2×4 ribband nailed across tops of joist
    b. Use strongbacks nailed across top of joist

20. Answer should include any four of the following.

    a. Plaster
    b. Drywall
    c. Acoustical glued to drywall or plaster
    d. Acoustical glued or nailed to furring strips
    e. Acoustical dropped in to metal grid systems
    f. Suspended ceiling metal grid system
    g. Heavy timber ceiling with or without exposed beams

21. a. 382 studs or 191 - 2×4s, 16 feet long for studs
    b. 72 - 2×4s, 16 feet long for plates

22. Performance skills evaluated to the satisfaction of the instructor

ROOF FRAMING
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able to identify different roof framing members and discuss roof framing. The student should also be able to construct a roof, including all openings and sheathing. The student will show this knowledge by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with roof framing.
2. List types of roof supports.
3. Identify roof framing members.
4. Label roof framing units.
5. Discuss slope and pitch ratios.
6. Identify the parts of a rafter.
7. List methods for determining rafter length.
8. Use a framing square to compute the length of a common rafter.
9. Use a framing square to compute the length of a hip rafter.
10. Use a framing square to compute the length of jack rafters.
11. Select from a list types of roof openings.
12. List types of vents used in roof construction.
13. Estimate material needed to frame a roof.
14. Demonstrate the ability to
    a. Lay out rafter locations on top plate and ridgeboard on 2-foot centers.
    b. Lay out, cut, and erect rafters.
    c. Frame a gable end with vent opening.
    d. Construct opening for a chimney.
    e. Apply roof sheathing.

ROOF FRAMING
UNIT III

SUGGESTED ACTIVITIES

I. Unit contents
   - A. Objective sheet
   - B. Suggested activities
   - C. Transparency masters
      1. TM #1 — Roof Framing Members
      2. TM #2 — Common-Rafter Layout
      3. TM #3 — Framing-Square Step-Off Method
      4. TM #4 — Rafter Tables on a Framing Square
      5. TM #5 — Main Parts of a Truss
      6. TM #6 — Length of Ridgeboard
      7. TM #7 — Dormer Framing
      8. TM #8 — Framing an Opening
   - D. Information sheet
   - E. Student Supplement #1 — The Framing Square
   - F. Assignment Sheet #1 — Estimate Materials Needed to Frame a Roof
   - G. Answers to assignment sheet
   - H. Job sheets
      1. Job Sheet #1 — Lay Out Rafter Locations on the Top Plate and Ridgeboard on 2-Foot Centers
      2. Job Sheet #2 — Lay Out, Cut, and Erect Rafters
      3. Job Sheet #3 — Frame a Gable End with Vent Opening
      4. Job Sheet #4 — Construct Opening for a Chimney
      5. Job Sheet #5 — Apply Roof Sheathing
   - I. Test
   - J. Answers to test

SUGGESTED ACTIVITIES

II. Instructor's guide

A. Review unit and plan presentation.

B. Obtain materials to supplement unit.

1. Pictures of various roof styles and roof supports
2. Plans to clarify definitions of terms associated with roof framing
3. Pictures or plans of various roof styles
4. Model to illustrate roof framing members
5. Local building regulations concerning roof framing and ventilation capacities
6. Model to illustrate roof units
7. Plans, tables, etc., that illustrate roof framing units and slope and pitch ratios
8. Color-coded model of a rafter
9. Framing square for each student
10. Model to explain why a common rafter must be shortened one-half the thickness of the ridgeboard
11. Samples of roof supports
12. Samples of vents used in roof construction
13. Literature from vent manufacturers
14. Transparency masters and compentency profiles

(NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational-Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W., Washington, D.C. 20006, phone 202-393-2040.)

SUGGESTED ACTIVITIES

C. Introduce unit.

SUGGESTIONS:

- Show the class pictures of various roof styles and emphasize how many different styles of roofs can be used for the same floor plan.

  (NOTE: You may want to use a front-elevation plan and overlay different roof designs so that the students can see the elevation with a gable, a hip, a modified hip, and other styles.)

- Use a framing square and Transparency #5 to show the calculations involved in roof framing. Emphasize the need for careful calculations to ensure proper fit.

  (NOTE: Emphasize the importance of mastering calculating skills, but do not make the task seem so difficult that students become discouraged.)

D. Provide students with objective sheet; discuss unit and specific objectives.

E. Provide students with information, assignment, and job sheets.

F. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I to discuss terms associated with roof framing. Use plans to clarify the definitions.

2. Use Information Sheet, Section II to discuss roof styles.

   SUGGESTIONS:

   - Display pictures of finished roofs or plans of the roof styles illustrated in this section of the information sheet.
   - Have students discuss structures in your area with various roof styles.
   - Discuss variations in and combinations of these roof styles.

3. Use Information Sheet, Section III and Transparency #1 to discuss roof framing members.

   (NOTE: A good reference for this section of the information sheet and the sections that follow is *Full-Length Roof Framer.* See Section III of Suggested Activities.)

   SUGGESTIONS:

   - Display a model to illustrate roof framing members three dimensionally.

SUGGESTED ACTIVITIES

- Discuss lumber sizes and grade requirements for roof framing members. Emphasize local building regulations.
- Tour construction sites to observe various roof styles in the framing stages.
- Relate styles of roofs to the various members discussed.

  (NOTE: Some students have difficulty envisioning the three-dimensional structure from line drawings. Provide additional help as needed and suggest ways that such students can improve their skills in this area, such as by constructing models or doing drawings with different views.)

4. Use Information Sheet, Secton IV and Transparency #2 to discuss roof framing units; use Information Sheet, Section V to discuss slope and pitch ratios.

   SUGGESTIONS:

   - Use a small model to discuss roof units. Emphasize the relationship among the units.

     EXAMPLES: Run is always stated as 12 inches; span is always stated as 24 inches; as rise increases, unit length and slope increase and projection decreases.

   - Make sure that students clearly understand pitch and slope; have the students compute pitch and slope for different rises and runs.
   - Provide students with plans, tables, etc., that use roof framing units and slope and pitch.

5. Use Information Sheet, Section VI to discuss parts of a rafter.

   SUGGESTIONS:

   - Display a color-coded model of a rafter to discuss the parts illustrated in this section of information sheet.
   - Discuss types of tail cuts.

     (NOTE: Tail cuts are covered in detail in Section E, Unit II, Roof Finishes.)

6. Use Information Sheet, Section VII and Transparencies #3 and #4 to discuss methods of determining rafter length; demonstrate each method.

SUGGESTED ACTIVITIES

7. Use Information Sheet, Section VIII and Student Supplement #1 to discuss using a framing square to compute the length of a common rafter.

   SUGGESTIONS:

   - Demonstrate the procedure and allow students to follow along on the supplement or with actual framing squares.
   - Use Transparency #6 or a model to explain why a common rafter must be shortened one-half the thickness of the ridgeboard.

8. Use Information Sheet, Sections IX and X to discuss using a framing square to compute rafter lengths for a hip rafter and jack rafter, relating the procedures to that used for a common rafter.

   SUGGESTION:

   - Make it clear to the students how the angles and lengths affect one another.

9. Provide students with Assignment Sheet #1 and house plans to practice computing rafter lengths.

10. Use Information Sheet, Section XII to discuss types of vents used in roof construction.

    SUGGESTIONS:

    - Show the class samples of each type of vent discussed in this section of the information sheet.
    - Discuss the purpose of roof ventilation or invite a manufacturer or distributor of roof-ventilation hardware to discuss vent applicatons.
    - Display literature from vent manufacturers.
    - Relate designs and sizes to ventilation capacities, emphasizing local regulations.

11. Use Information Sheet, Section XIII and Transparency #5 to discuss estimating material needed to frame a roof.

    SUGGESTIONS:

    - Have students practice estimating material by completing Assignment Sheet #1.
    - Provide students with plans to estimate materials.
    - Have students compute cost differences in framing materials for houses using different pitches, different designs, or prefabricated trusses instead of on-site framing.
    - Use Transparencies #6 and #7 to discuss other considerations in framing materials.

SUGGESTED ACTIVITIES

G. Discuss job sheets and demonstrate procedures.

SUGGESTIONS:

- Review safety requirements, empahsizing ladder and scaffolding safety.
- Review framing concepts studied in previous units.
- Relate Job Sheet #1 to joist layout and installation.
- Allow students to practice procedures in Job Sheet #2; you may wish to allow students to make the pattern rafters and do the computations for other rafters required for the example used in the job sheet.

H. Have students complete job sheets.

I. Give test.

J. Critique test and discuss in class.

K. Reteach if necessary.

L. Complete appropriate portions of competency profiles.

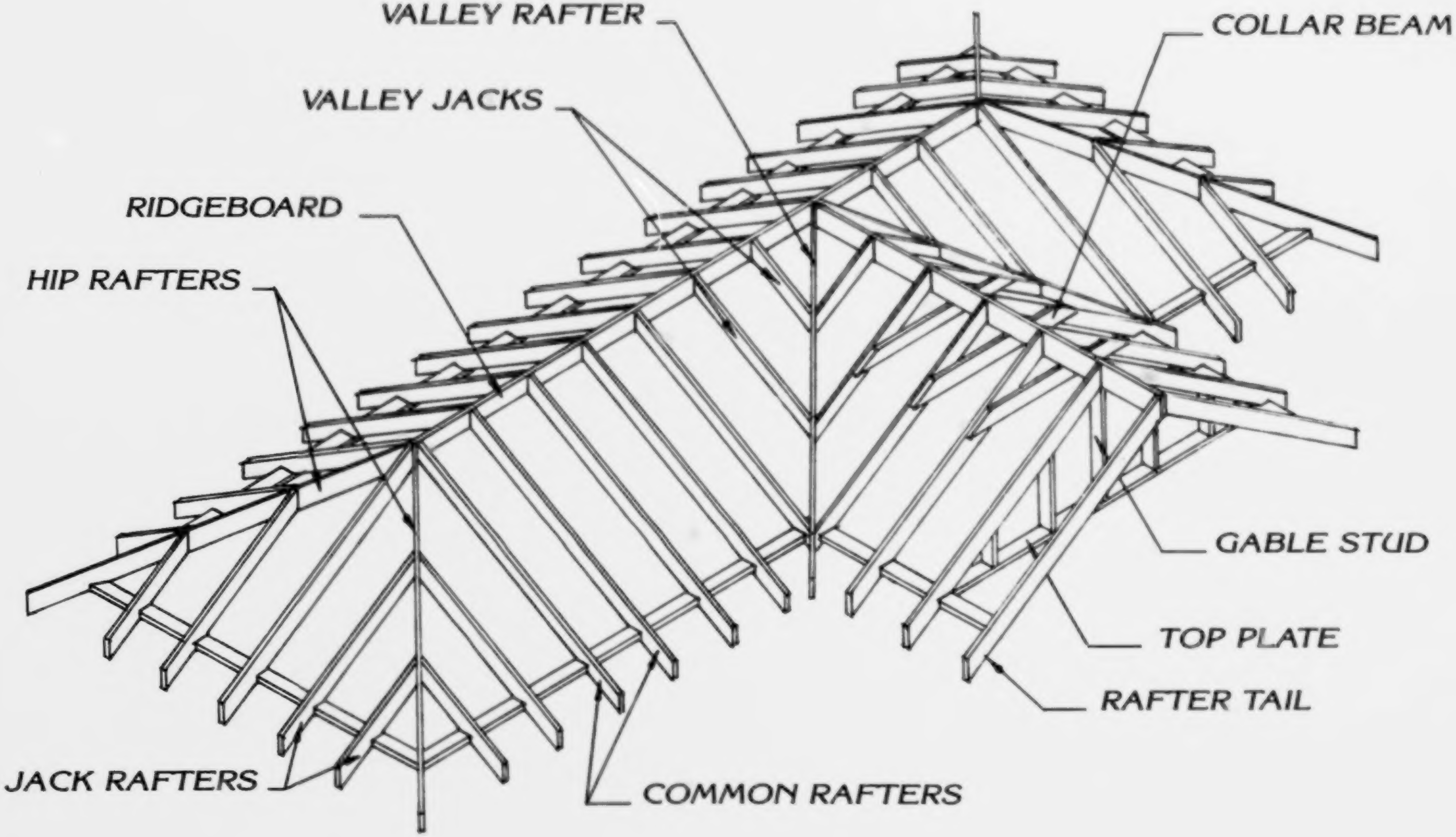
III. Unit references

A. Hendrix, Laborn J. "Bud." *Commercial Carpentry.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

B. Riechers, A. F. J. *Full-Length Roof Framer.* Palo Alto, California: Ledever, Street, and Zeus Co., Inc., 1944.

C. Wagner, Willis H. *Modern Carpentry.* South Holland, Illinois: The Goodheart-Willcox Company, 1976.

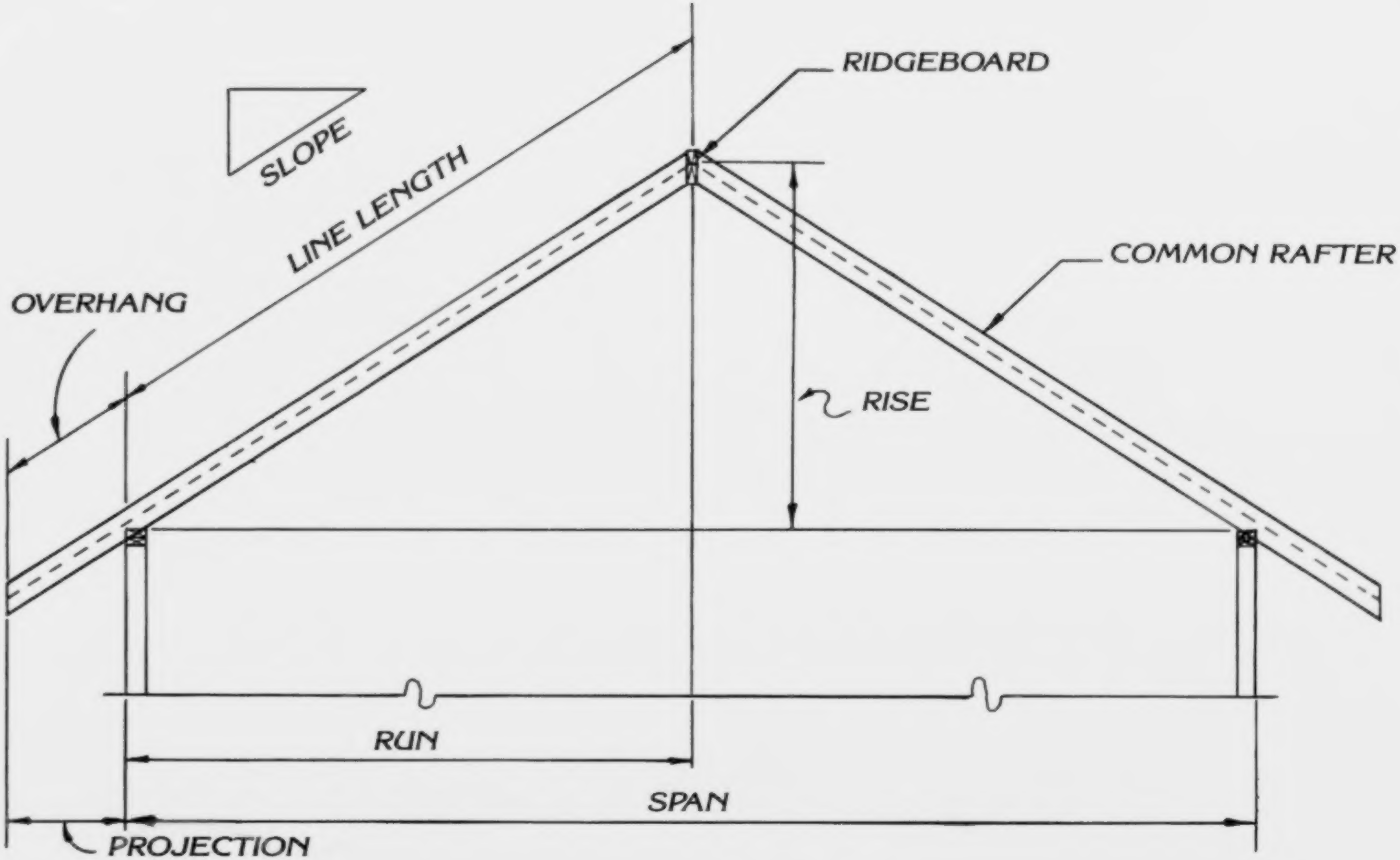
Roof Framing Members


VALLEY RAFTER
COLLAR BEAM
VALLEY JACKS
RIDGEBOARD
HIP RAFTERS
GABLE STUD
TOP PLATE
RAFTER TAIL
HIP JACK RAFTERS
COMMON RAFTERS

TM #1

CC - 185-B

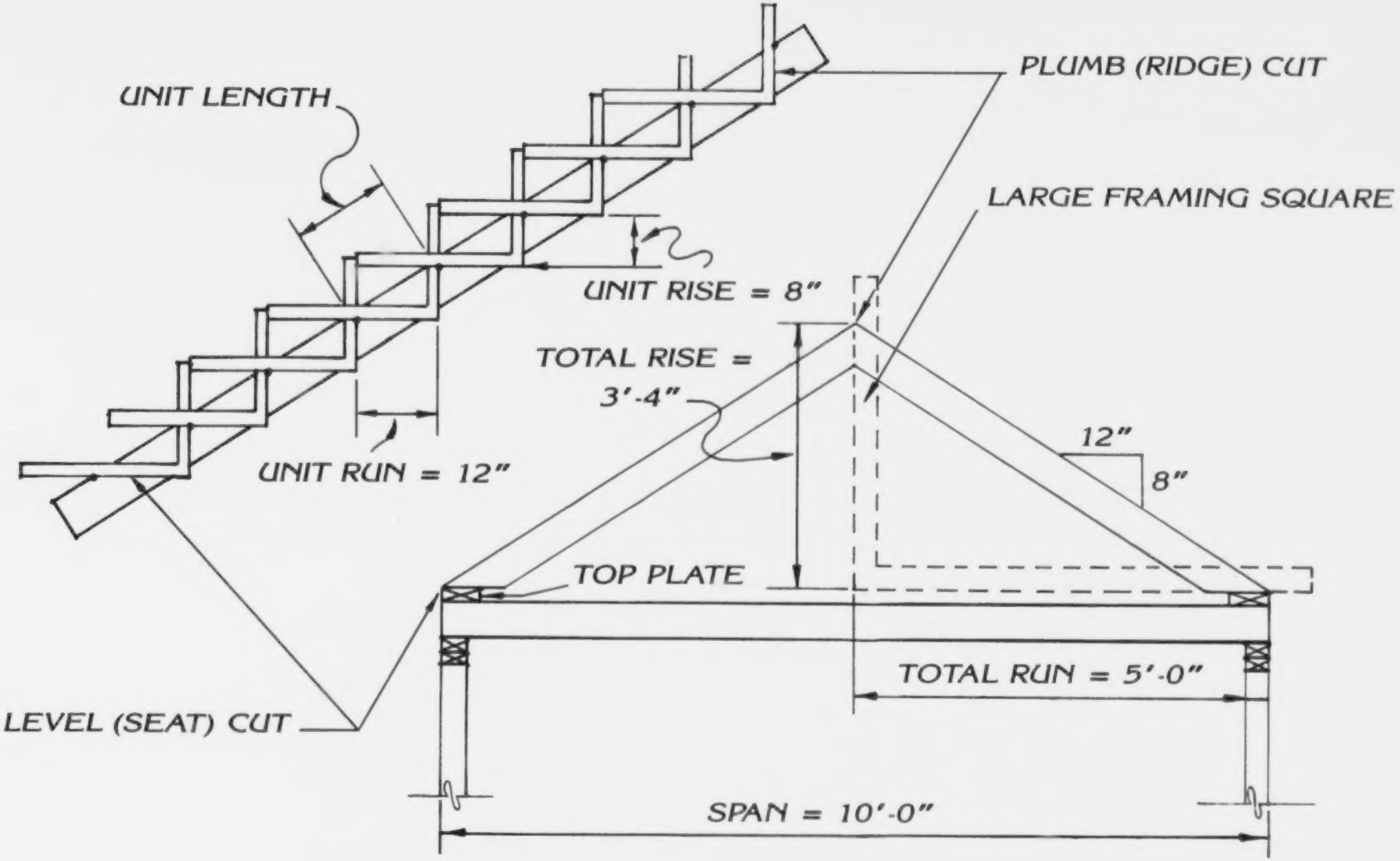
Common-Rafter Layout


RIDGEBOARD
SLOPE
LINE LENGTH
OVERHANG
COMMON RAFTER
RISE
RUN
SPAN
PROJECTION

TM #2

CC - 187-B

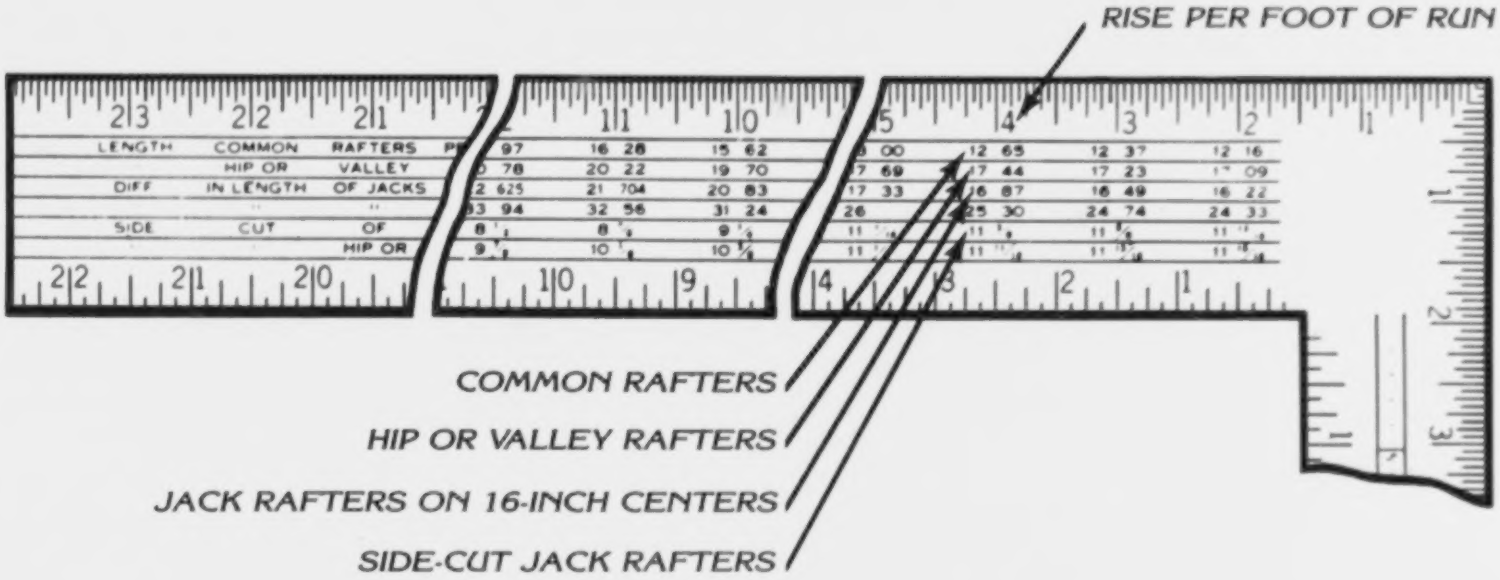
Framing-Square Step-Off Method


UNIT LENGTH
PLUMB (RIDGE) CUT
LARGE FRAMING SQUARE
UNIT RISE = 8"
TOTAL RISE =
3'-4"
12"
8"
UNIT RUN = 12"
TOP PLATE
TOTAL RUN = 5'-0"
LEVEL (SEAT) CUT
SPAN = 10'-0"

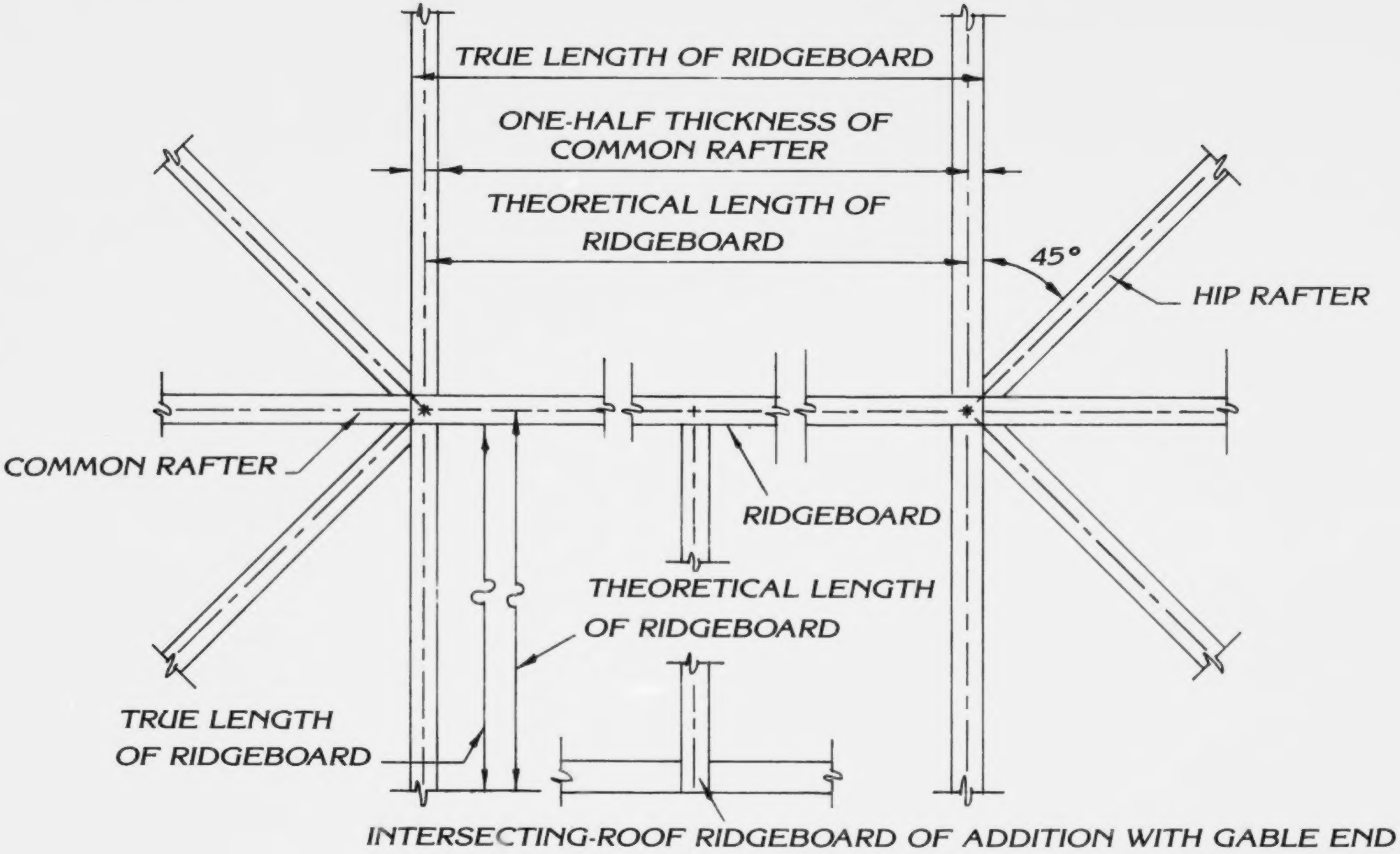
TM #3

CC - 189-B

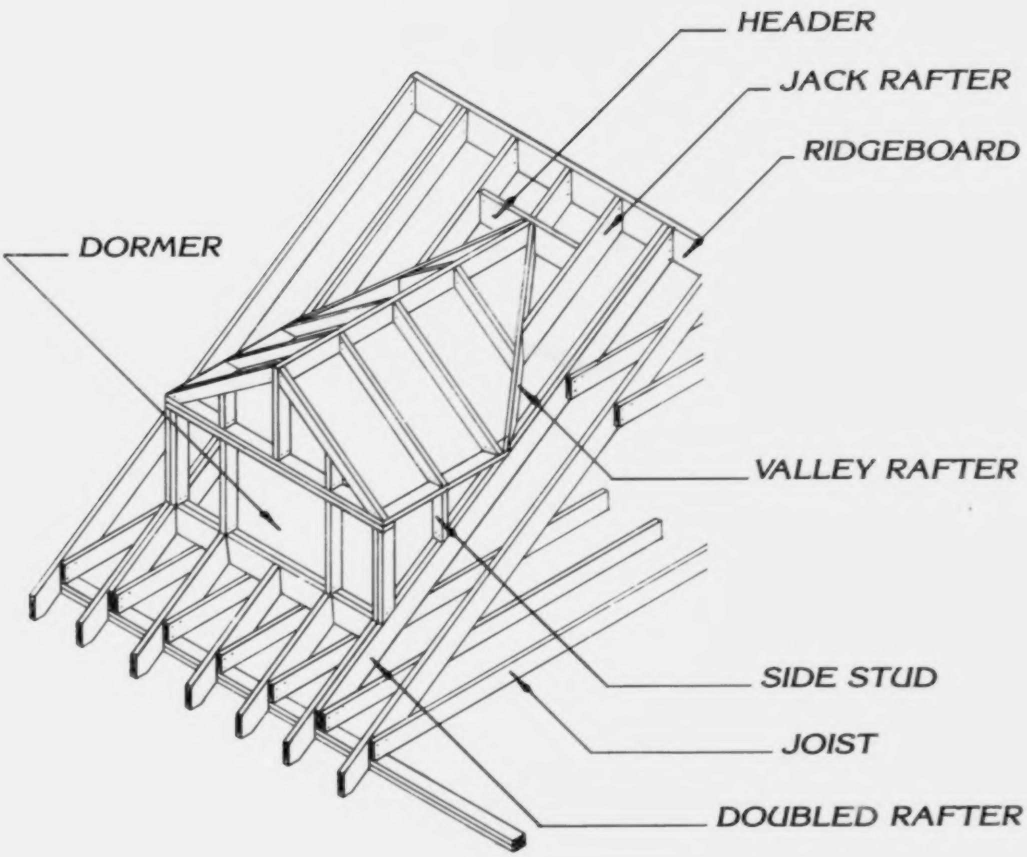
Rafter Tables on a Framing Square


RISE PER FOOT OF RUN
LENGTH COMMON RAFTERS PER
HIP OR VALLEY
DIFF IN LENGTH OF JACKS
SIDE CUT OF
HIP OR
COMMON RAFTERS
HIP OR VALLEY RAFTERS
JACK RAFTERS ON 16-INCH CENTERS
SIDE-CUT JACK RAFTERS

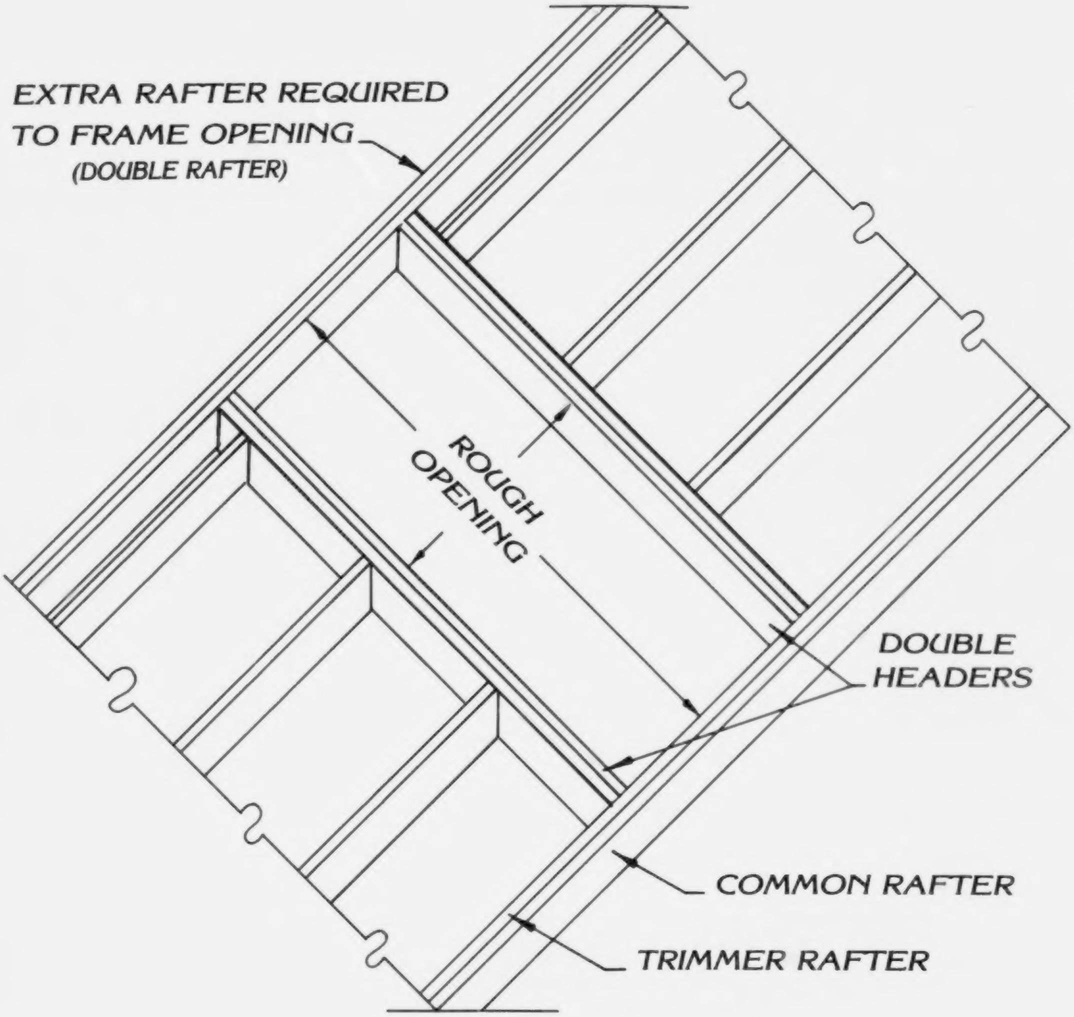
Length of Ridgeboard


TRUE LENGTH OF RIDGEBOARD
ONE-HALF THICKNESS OF COMMON RAFTER
THEORETICAL LENGTH OF RIDGEBOARD
45°
HIP RAFTER
COMMON RAFTER
RIDGEBOARD
THEORETICAL LENGTH OF RIDGEBOARD
TRUE LENGTH OF RIDGEBOARD
INTERSECTING-ROOF RIDGEBOARD OF ADDITION WITH GABLE END

Dormer Framing


HEADER
JACK RAFTER
RIDGEBOARD
DORMER
VALLEY RAFTER
SIDE STUD
JOIST
DOUBLED RAFTER

Framing an Opening


EXTRA RAFTER REQUIRED
TO FRAME OPENING
(DOUBLE RAFTER)
ROUGH OPENING
DOUBLE HEADERS
COMMON RAFTER
TRIMMER RAFTER

ROOF FRAMING
UNIT III

INFORMATION SHEET

I. Terms and definitions associated with roof framing

A. Common rafter — Rafter that extends from double top plate to ridgeboard; roof's main framing member

B. Valley rafter — Rafter that extends diagonally from top plate to form the intersection of an internal roof angle

C. Hip rafter — Rafter that extends from double top plate at corner of structure to ridgeboard, forming the angle for a hip roof

D. Jack rafter — Short rafter that fits between top plate and hip or valley rafter, or between ridgeboard and hip or valley rafter

(NOTE: When fitted between hip and valley rafter, a jack rafter is called a *cripple jack*.)

E. Barge rafter (verge rafter) — Exposed rafter that is located at end of gable roof

F. Pitch — Angle or degree of slope of roof

G. Slope — Inclination of roof's surface expressed as one unit of rise or fall to so many horizontal units, usually "X" inches in twelve

EXAMPLES: 4 in 12, 5 in 12

H. Span — Horizontal distance from outside of one exterior wall to outside of opposite exterior wall

I. Run — Horizontal distance from outside of top plate to centerline of ridgeboard; usually one-half of span

J. Rise — Total height of rafter above top plate

K. Projection — Horizontal distance from building to edge of roof

L. Overhang — Section of roof that extends from building line to edge of roof

M. Rake — Trim members that run parallel to roof slope and form finish between roof and wall at gable end

N. Dormer — Structure that projects from a sloping roof and usually includes a window

O. Strongback (stiffback) — Brace used in framing to strengthen or improve alignment of other framing members

INFORMATION SHEET

P. Scuttle — Small opening in a wall or roof furnished with a lid

Q. Hatch — Small door or opening in the floor or roof of a building

R. False fascia — Horizontal material the same thickness and width as roof rafters nailed to rafter tails and covered with finish fascia board

(NOTE: False fascia is also called rough fascia or sub fascia.)

II. Types of roof supports

A. Wood rafters

B. Wood trusses

C. Structural timbers

D. Wood bar joists

E. Metal trusses

F. Metal bar joists

G. Structural steel

H. Steel purlins

I. Precast concrete joists

J. Precast concrete planks

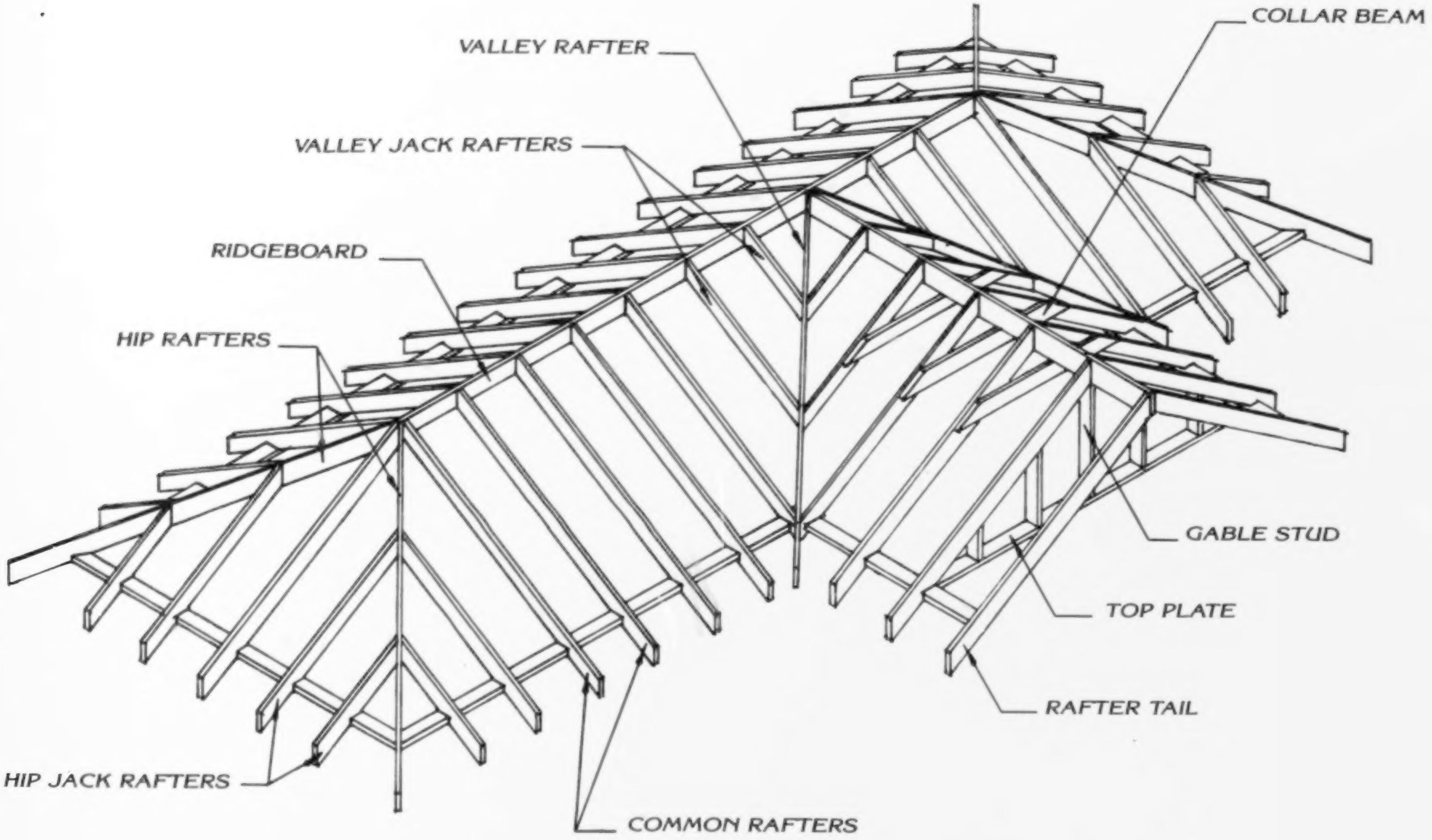
K. Poured in place concrete beams

L. Glue-laminated arches

INFORMATION SHEET

III. Roof framing members (Figure 1)

FIGURE 1

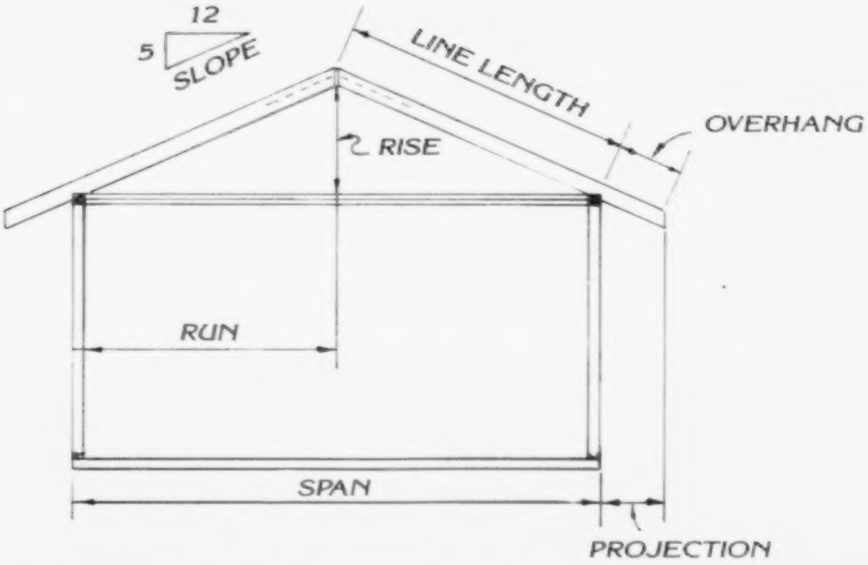

VALLEY RAFTER
COLLAR BEAM
VALLEY JACK RAFTERS
RIDGEBOARD
HIP RAFTERS
GABLE STUD
TOP PLATE
RAFTER TAIL
HIP JACK RAFTERS
COMMON RAFTERS

INFORMATION SHEET

IV. Roof framing units (Figure 2)

(NOTE: When determining total span, thickness of wall sheathing must be considered, if it covers top plate.)

FIGURE 2



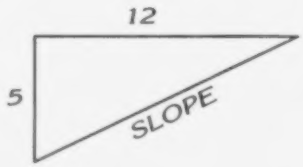
V. Slope and pitch ratios

A. Slope — Indicates incline of roof as a ratio of vertical rise to horizontal run

(NOTE: Slope is properly expressed as "X" inches in twelve. For example, a roof that has a rise of 5 inches for each foot of run is referred to as having a 5 in 12 slope. See Figure 3.)

EXAMPLE:

FIGURE 3



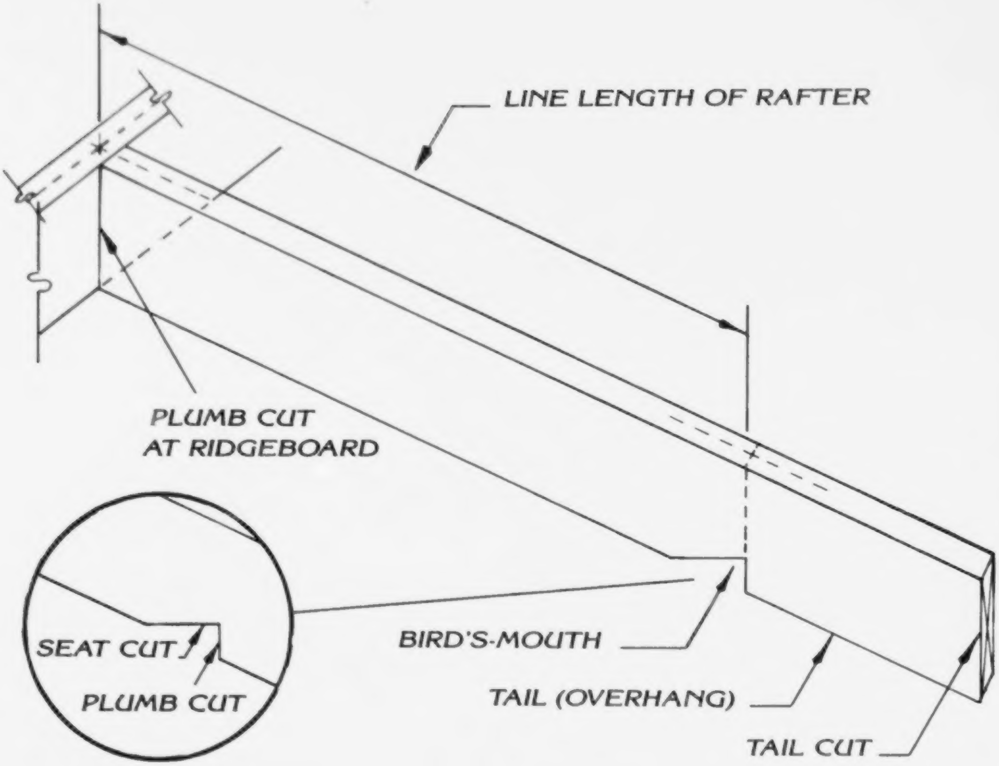
B. Pitch — Indicates incline of roof as a ratio of vertical rise to span

(NOTE: Pitch is expressed as a fraction. For example, if the total roof rise is 6 feet and total span is 24 feet, the pitch would be 1/4.)

INFORMATION SHEET

VI. Parts of a rafter (Figure 4)

FIGURE 4


LINE LENGTH OF RAFTER
PLUMB CUT AT RIDGEBOARD
SEAT CUT
PLUMB CUT
BIRD'S-MOUTH
TAIL (OVERHANG)
TAIL CUT

VII. Methods for determining rafter length

A. Framing-square step-off method

B. Rafter tables

(NOTE: Rafter tables are usually located on the backs of framing squares. Rafter tables usually give lengths in length per foot of run, but some tables give lengths in length per given run.)

VIII. Using a framing square to compute the length of a common rafter

(NOTE: Refer to the framing square illustrated in Student Supplement #1 at the end of the information sheet.)

A. Determine common-rafter span (in inches) by measuring from outside of top plate on one sidewall to outside of top plate on opposite sidewall

INFORMATION SHEET

B. Divide span by 2 to find actual run of common rafter

(NOTE: Actual run equals one-half of span.)

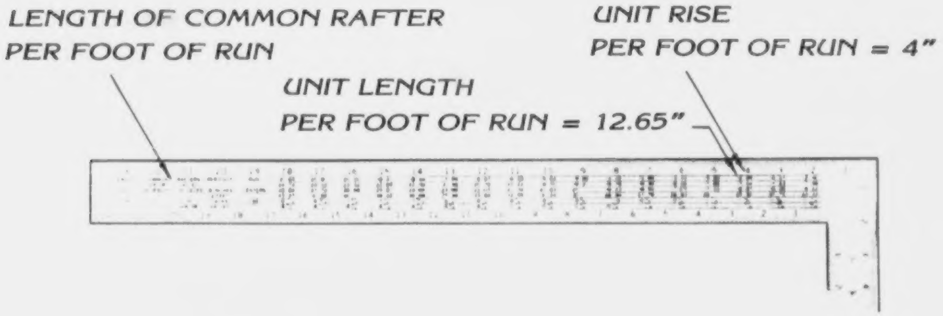
C. Determine inches of rise per foot of run

D. Determine shortened length of common rafter

1. Locate unit rise per foot of run on blade of framing square

EXAMPLE: If unit rise is 4 inches per foot of run, locate the number four on the edge of the framing-square blade. See Figure 5.

FIGURE 5



2. Read figure under unit rise per foot of run to find the unit length per foot of run for the common rafter

EXAMPLE: If the span for a structure is 20'-0" and the unit rise per foot of run is 4 inches, then the unit length per foot of run is 12.65 inches. See Figure 5.

3. Multiply unit length per foot of run by actual run and divide by 12 (12 inches equal 1 foot) to find the length of common rafter in feet and inches, or

Unit Length per Foot of Run × Actual Run ÷ 12 = Length of Common Rafter

EXAMPLE #1: If the actual run of a structure is 10 and unit length per foot of run is 12.65 inches, then

$$\frac{12.65'' \times 10}{12} = \frac{126.50 \text{ inches}}{12} = 10.54 \text{ feet, which} = 10'\text{-}6\ ^{1}/_{2}''$$

INFORMATION SHEET

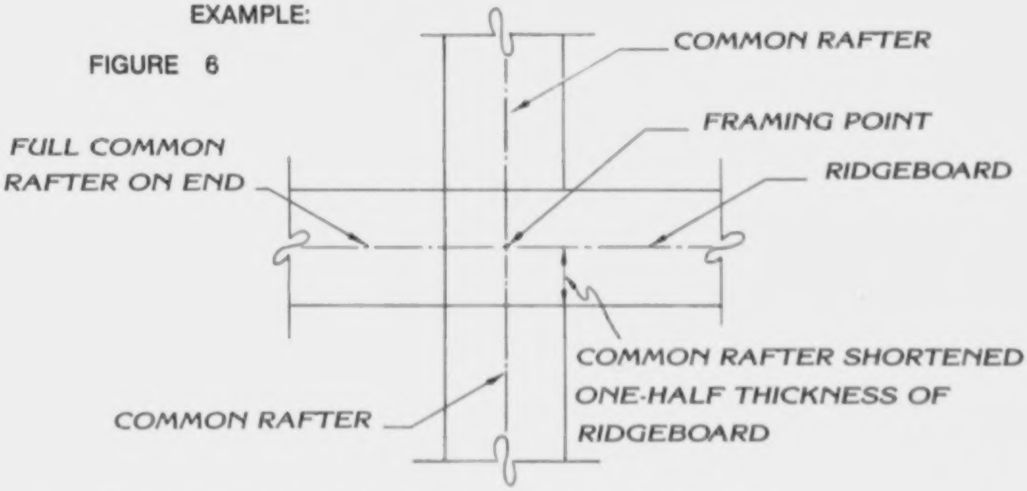
EXAMPLE #2: If the actual run of a structure is 12.3 and unit length per foot of run is 12.42 inches, then

$$\frac{12.42'' \times 12.3}{12} = \frac{152.77 \text{ inches}}{12} = 12.73 \text{ feet, which} = 12'\text{-}8\ \tfrac{3}{4}''$$

4. Subtract one-half thickness of ridgeboard (measured perpendicular to plumb cut of rafter) from length of common rafter to find shortened length of common rafter (Figure 6)

EXAMPLE:

FIGURE 6


COMMON RAFTER
FRAMING POINT
FULL COMMON RAFTER ON END
RIDGEBOARD
COMMON RAFTER SHORTENED ONE-HALF THICKNESS OF RIDGEBOARD
COMMON RAFTER

IX. Using a framing square to compute the length of a hip rafter

(NOTE: Refer to the framing square illustrated in Student Supplement #1 at the end of the information sheet.)

A. Determine the hip-rafter span (in inches) by measuring from outside of top plate on one sidewall to outside of top plate on opposite sidewall

B. Divide span by 2 to find actual run of hip rafter

(NOTE: Actual run equals one-half of span.)

C. Determine inches of rise per foot of run

D. Determine shortened length of hip rafter

1. Locate unit rise per foot of run on blade of framing square (See Figure 7)

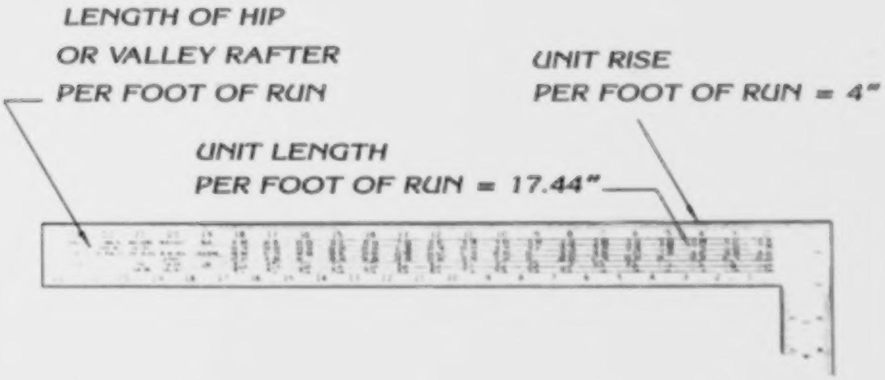
2. Read figure under unit rise per foot of run to find the unit length per foot of run for the hip or valley rafter

EXAMPLE: If the unit rise is 4 inches per foot of run, the unit length is 17.44 inches per foot of run. (See Figure 7)

INFORMATION SHEET

EXAMPLE:

FIGURE 7


LENGTH OF HIP
OR VALLEY RAFTER
PER FOOT OF RUN
UNIT RISE
PER FOOT OF RUN = 4"
UNIT LENGTH
PER FOOT OF RUN = 17.44"

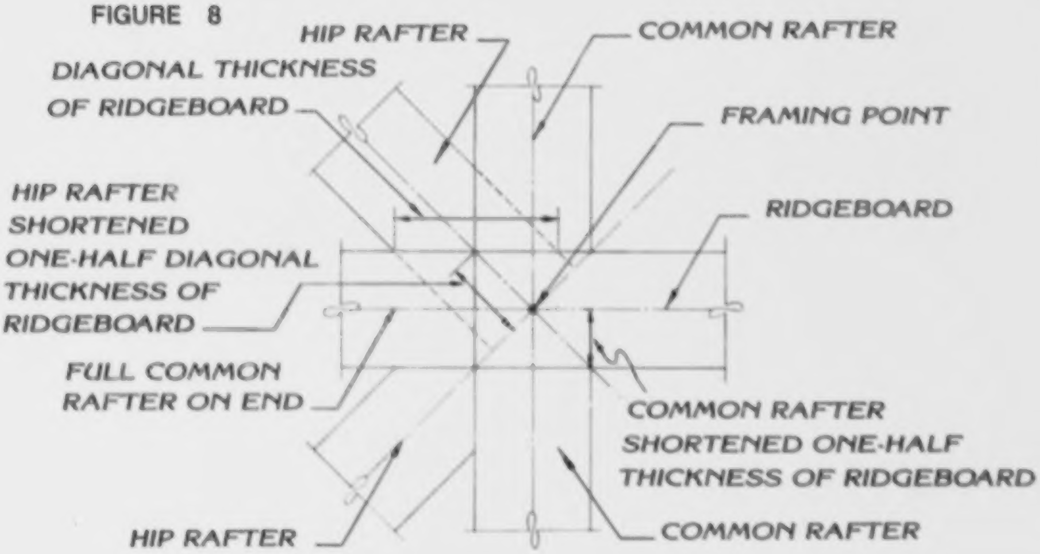
3. Multiply unit length per foot of run by actual run and divide by 12 to find the length of hip rafter (in feet), or

$$\frac{\text{Unit Length per Foot of Run} \times \text{Actual Run}}{12} = \text{Length of Hip Rafter}$$

4. Subtract one-half diagonal thickness of ridgeboard from length of hip rafter to find shortened length of hip rafter (Figure 8)

EXAMPLE:

FIGURE 8


HIP RAFTER
COMMON RAFTER
DIAGONAL THICKNESS
OF RIDGEBOARD
FRAMING POINT
HIP RAFTER
SHORTENED
ONE-HALF DIAGONAL
THICKNESS OF
RIDGEBOARD
RIDGEBOARD
FULL COMMON
RAFTER ON END
COMMON RAFTER
SHORTENED ONE-HALF
THICKNESS OF RIDGEBOARD
HIP RAFTER
COMMON RAFTER

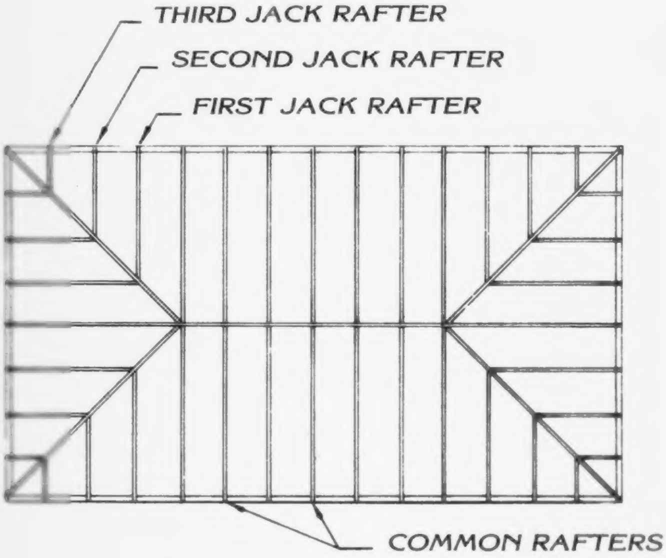
INFORMATION SHEET

X. Using a framing square to compute the length of jack rafters

(NOTE: Refer to the framing square illustrated in Student Supplement #1 at the end of the information sheet and to Figure 9.)

EXAMPLE:

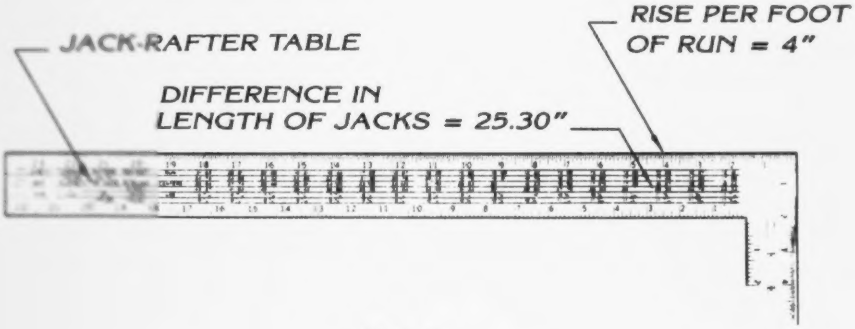
FIGURE 9


THIRD JACK RAFTER
SECOND JACK RAFTER
FIRST JACK RAFTER
COMMON RAFTERS

A. Locate unit rise per foot of run on blade of framing square (Figure 10)

EXAMPLE:

FIGURE 10


JACK-RAFTER TABLE
RISE PER FOOT
OF RUN = 4"
DIFFERENCE IN
LENGTH OF JACKS = 25.30"

INFORMATION SHEET

B. Determine shortened length of common rafter (See Section VIII of information sheet)

C. Determine difference in length of jacks by locating table on blade of framing square

EXAMPLE: If the unit rise is 4 inches, the difference in length for jacks is 25.30 inches. See Figure 10.

D. Subtract difference in length of jacks from shortened length of common rafter (in inches) to find length of first jack rafter, or

Common Rafter Length - Difference in Length of Jacks = Length of First Jack Rafter

EXAMPLE: If the difference in length for jacks is 25.30 inches, the length of the first jack rafter will be 25.30 inches shorter than that of the shortened common rafter.

E. Subtract the difference in length of jacks from length of first jack rafter to find length of second jack rafter

EXAMPLE: If the difference in length for jacks is 25.30 inches, the second jack rafter will be 25.30 inches shorter than the first jack rafter.

F. Subtract the difference in length of jacks from length of second jack rafter to find length of third jack rafter

EXAMPLE: If the difference in length for jacks is 25.30 inches, the third jack rafter will be 25.30 inches shorter than the second jack rafter.

G. Follow procedure above to compute the length of all jack rafters that will be required

XI. Types of roof openings

A. Roof exit doors

B. Roof vents

C. Chimneys

D. Roof windows

1. Stationary

2. Ventilating

INFORMATION SHEET

E. Sky lights

F. Roof hatches (scuttles)

   1. Ladder access
   2. Stair access
   3. Fire and smoke vents

G. Louvers

   1. Stationary
   2. Adjustable

H. Firewalls

XII. Types of vents used in roof construction

(NOTE: Most vents are backed with screen to prevent entry of birds and insects.)

A. Three-inch miniature round vent

(NOTE: This vent is often used to ventilate rafter space in structures with flat roofs.)

B. Four-inch miniature round vent

(NOTE: This vent is used in hard-to-reach places needing large ventilating area and is large enough to vent soffits.)

C. Ridge vent

(NOTE: This vent provides 18 square inches of net-free area per lineal foot when installed over a 1½-inch gap in the sheathing at the ridge.)

D. Roof vent

(NOTE: This vent is used to pull hot air out of the attic. It fits over an opening cut between the rafters.)

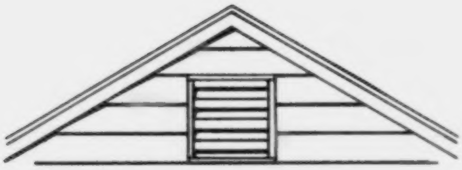
E. Square attic vent (See Figure 11)

(NOTE: This wood or metal vent is installed in the gable end and used to ventilate the attic area.)

INFORMATION SHEET

EXAMPLE:

FIGURE 11

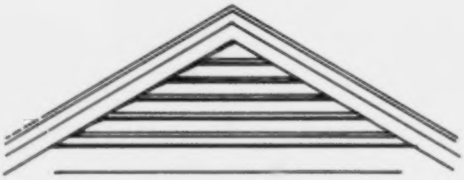


F. Triangular attic vent (Figure 12)

(NOTE: This triangular wood or metal attic vent is installed snugly under the roof gable to provide a large vent area at the highest point of the gable end.)

EXAMPLE:

FIGURE 12

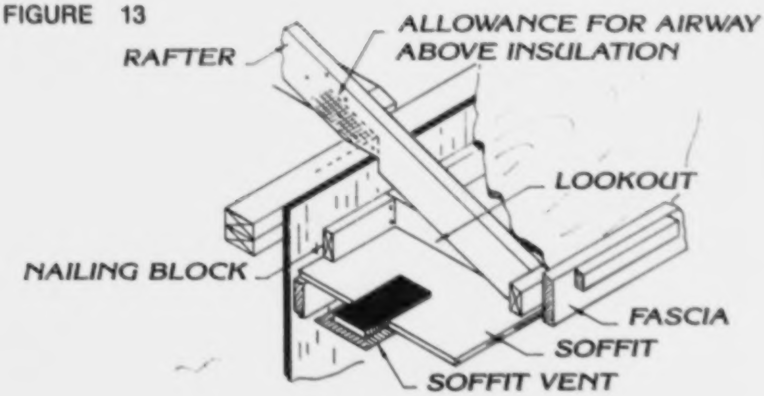


G. Soffit vent (Figure 13)

(NOTE: This vent replaces a portion of the soffit material to provide continuous ventilation at intervals along the length of the soffit. This type of vent may be made of a stamped or extruded vent strip, a perforated prefinished aluminum panel, or a perforated sheet of fiber materials.)

EXAMPLE:

FIGURE 13


ALLOWANCE FOR AIRWAY ABOVE INSULATION
RAFTER
LOOKOUT
NAILING BLOCK
FASCIA
SOFFIT
SOFFIT VENT

INFORMATION SHEET

XIII. Estimating materials needed to frame a roof

(NOTE: Approximately the same amount of framing material is required for either a gable or hip roof.)

A. Gable roof with rafters on 2-foot centers

1. Rafters

    a. Determine length of common rafters, including overhang (See Section VIII of the information sheet.)

    b. Determine number of common rafters needed by measuring length of one side of structure, rounding up to next foot, and dividing that number by 2

    c. Add six additional rafters: two for end rafters and four for barge rafters

    (NOTE: Barge rafters are usually one dimension narrower or thinner than common rafters.)

2. Ridgeboard

    (NOTE: The ridgeboard should be the next dimension wider than the rafter material.)

    a. Determine length of plate on one side of structure

    b. Add amount of projection over each gable end for a simple rectangular structure

B. Hip roof with rafters on 2-foot centers

1. Rafters

    a. Determine length of common rafters, including overhang (See Section VIII of the information sheet.)

    b. Determine length of hip rafters, including overhang (See Section IX of the information sheet.)

    (NOTE: Jack rafters are simply common rafters that have been shortened.)

    c. Determine number of common and jack rafters needed for a simple rectangular area by measuring length of one side of structure, rounding up to next foot, and dividing that number by 2

    d. Add two end rafters or four barge rafters where used

    e. Add one hip rafter for each corner

INFORMATION SHEET

2. Ridgeboard

   a. Measure length of structure

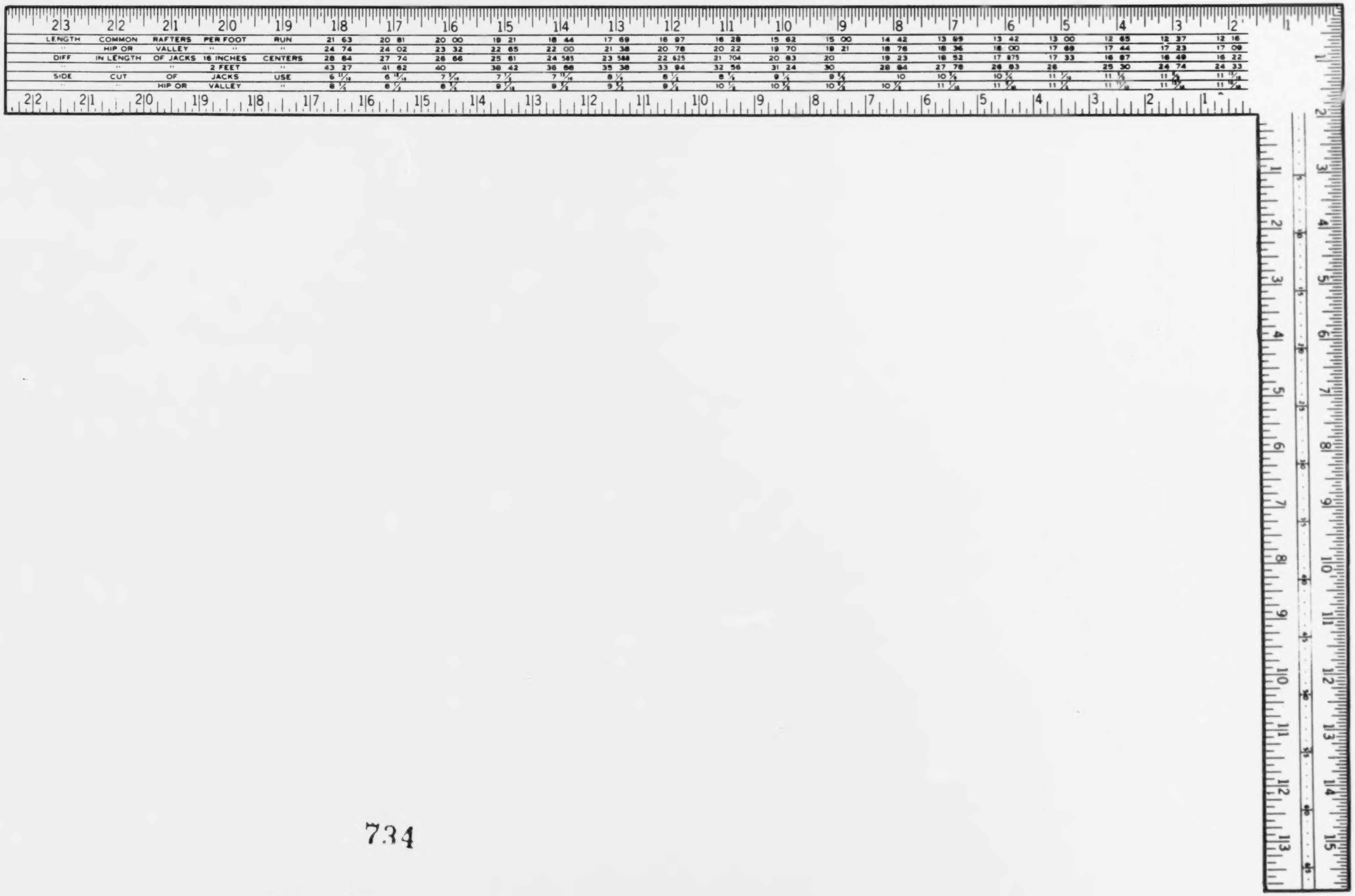
   b. Measure width of structure

   c. Subtract width from length

   d. Add thickness of ridgeboard to remainder to find actual ridgeboard length

ROOF FRAMING
UNIT III

STUDENT SUPPLEMENT #1 — THE FRAMING SQUARE


23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
LENGTH COMMON RAFTERS PER FOOT RUN 21 63 20 81 20 00 19 21 18 44 17 69 16 97 16 28 15 62 15 00 14 42 13 89 13 42 13 00 12 65 12 37 12 16
" HIP OR VALLEY " " " 24 74 24 02 23 32 22 65 22 00 21 38 20 78 20 22 19 70 19 21 18 76 18 36 18 00 17 69 17 44 17 23 17 09
DIFF IN LENGTH OF JACKS 16 INCHES CENTERS 28 84 27 74 26 66 25 61 24 585 23 588 22 625 21 704 20 83 20 19 23 18 52 17 875 17 33 16 87 16 49 16 22
" " " 2 FEET " 43 27 41 62 40 38 42 36 88 35 38 33 94 32 56 31 24 30 28 84 27 78 26 83 26 25 30 24 74 24 33
SIDE CUT OF JACKS USE 6 11/16 6 15/16 7 3/16 7 1/2 7 13/16 8 1/8 8 1/2 8 7/8 9 1/4 9 5/8 10 10 3/8 10 3/4 11 1/16 11 3/8 11 5/8 11 13/16
" " HIP OR VALLEY " 8 1/4 8 1/2 8 3/4 9 1/16 9 3/8 9 5/8 9 7/8 10 1/8 10 3/8 10 5/8 10 7/8 11 1/16 11 5/16 11 1/2 11 11/16 11 13/16 11 15/16
22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
2 3 4 5 6 7 8 9 10 11 12 13 14 15
1 2 3 4 5 6 7 8 9 10 11 12 13

ROOF FRAMING
UNIT III

ASSIGNMENT SHEET #1 — ESTIMATE MATERIALS NEEDED TO FRAME A ROOF

NAME ______________________________ SCORE ______________

Accurate roof framing is a difficult task that requires skill and care. One of the skills required is the ability to accurately compute the lengths of framing members and to estimate the materials needed.

Using the information sheet, a framing square, and the illustrations that follow, calculate the materials needed for the roof members listed. Write your answers in the blanks and show your work.

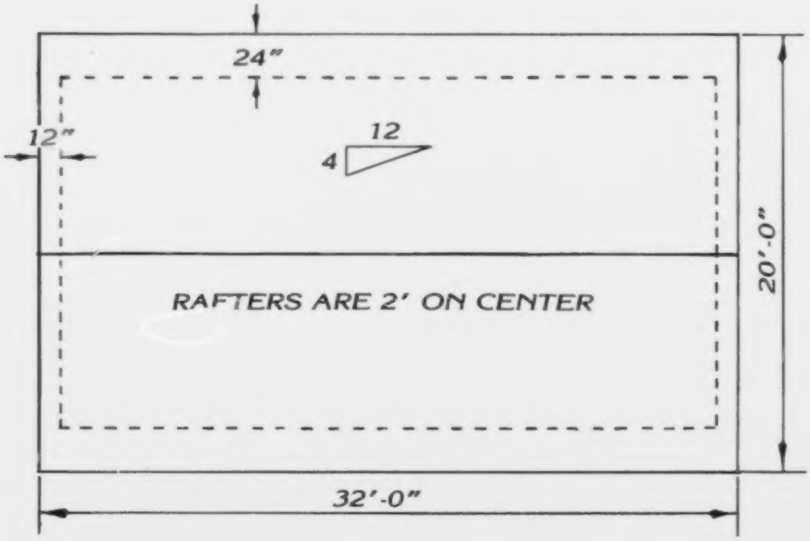
Part I — Gable roof

A. Common-rafter length = ______________________________

B. Ridgeboard length = ______________________________

C. Total 2×6 material needed = ______________________________

D. Total 2×8 material needed = ______________________________



ASSIGNMENT SHEET #1

Part II — Hip roof

A. Common-rafter length = ____________________

B. Hip-rafter length = ____________________

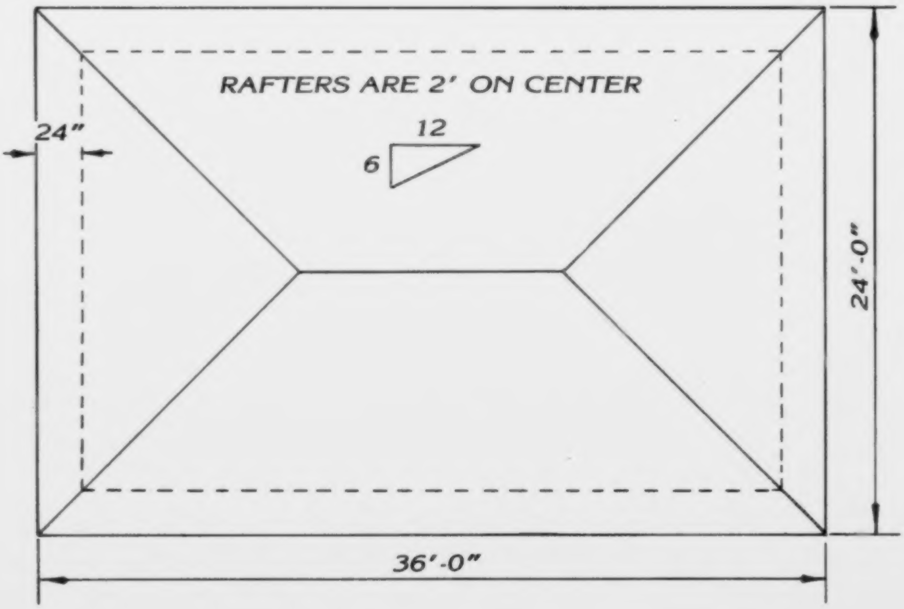
C. Ridgeboard length = ____________________

D. Length of each jack rafter

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________

E. Total 2×6 material needed = ____________________

F. Total 2×8 material needed = ____________________


RAFTERS ARE 2' ON CENTER
24"
12
6
24'-0"
36'-0"

ROOF FRAMING
UNIT III

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1
(NOTE: Because estimating answers will vary considerably, answers should be evaluated to the satisfaction of the instructor.)

Part I

A. 10′-6½″

B. 32′-0″

C. Thirty-eight 2″× 6″×12′

D. Two 2″× 8″×16′

Part II

A. 13′-5″

B. 18′-0″

C. 12′-0″

D.
  1. 11′-2⅛″
  2. 8′-11¼″
  3. 6′-8⅜″
  4. 4′-5½″
  5. 2′-2⅝″

E.
  1. Nine 2″× 6″×12′
  2. Twenty 2″× 6″×14′
  3. Eleven 2″× 6″×18′

F. One 2″× 8″× 12′

ROOF FRAMING
UNIT III

JOB SHEET #1 — LAY OUT RAFTER LOCATIONS ON THE TOP PLATE AND RIDGEBOARD ON 2-FOOT CENTERS

I. Tools and materials

  A. Folding rule or steel tape

  B. Framing square

  C. Completed wall sections with double top plate

  D. Ridgeboard material

II. Procedure

(NOTE: This procedure may be done while laying out ceiling joists. For simplification, ceiling-joist markings are not shown in illustrations.)

  A. Gable roof (with box cornice)

    1. Cut ridgeboard to correct length, allowing for barge rafter at each end if used

    2. Lay out rafter locations on double top plate

      a. Begin at one end of top plate and locate first rafter flush with end of top plate

      b. Use steel tape with the "0" end held against the left outside end of wall to mark 2-foot locations on top plate; mark an "R" to the right of each mark (See Figure 14)

      c. Set last rafter flush with outside of opposite end of structure

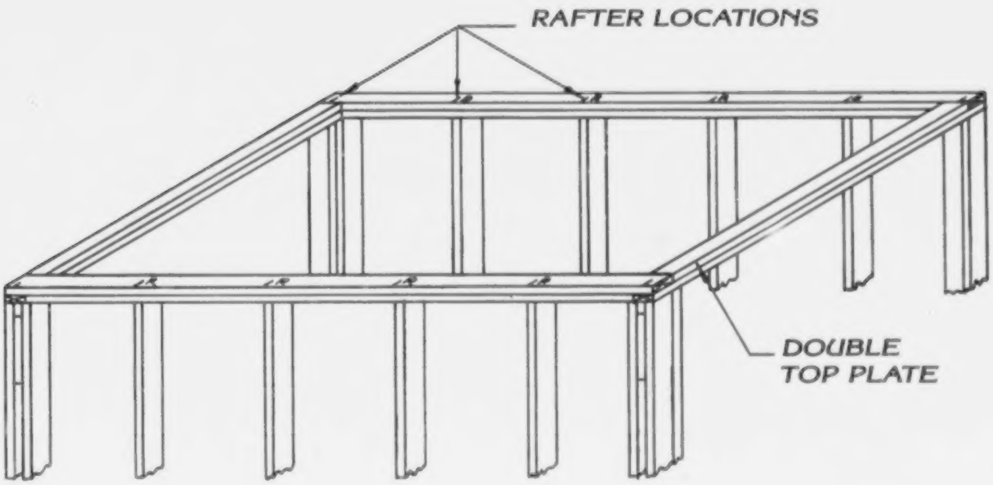
      (NOTE: The spacing between the last two rafters may be less than—but not more than—2 feet.)

      d. Use framing square to square a line across top plate at each 2-foot mark

      e. Repeat the marking process on opposite top plate, being sure to start from same end of structure; work from right to left (See Figure 14)

JOB SHEET #1

FIGURE 14



3. Lay out ridgeboard

   a. Place ridgeboard on edge on top of top plate with required projection at each end

   b. Mark ridgeboard on both sides to correspond to marks on top plate

   c. Use framing square to square lines across face of ridgeboard at each mark, and write an "R" to the right of each mark as for the top plate

B. Hip roof

1. Cut ridgeboard to correct length

   a. Measure length of sidewall between ends of plate

   b. Measure length of end wall from outside of plates

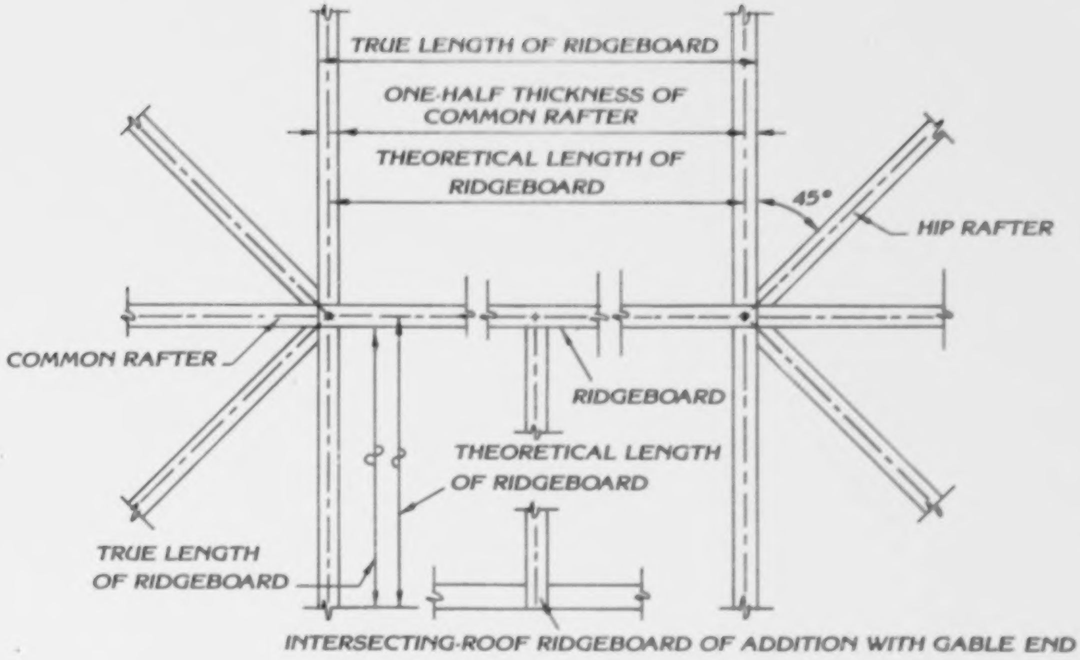
   c. Subtract length of end wall from length of sidewall

   d. Add thickness of ridgeboard to difference found in step c

   e. Measure and cut ridgeboard to required length (See Figure 15)

JOB SHEET #1

FIGURE 15


TRUE LENGTH OF RIDGEBOARD
ONE-HALF THICKNESS OF COMMON RAFTER
THEORETICAL LENGTH OF RIDGEBOARD
45°
HIP RAFTER
COMMON RAFTER
RIDGEBOARD
THEORETICAL LENGTH OF RIDGEBOARD
TRUE LENGTH OF RIDGEBOARD
INTERSECTING-ROOF RIDGEBOARD OF ADDITION WITH GABLE END

2. Lay out rafter locations on top plate

   a. Measure one-half the width of the structure from the end on top plate of one sidewall

      (NOTE: This locates the center of the first rafter.)

   b. Mark one-half the thickness of rafter on either side of this mark

   c. Space all other rafters, both commons and jacks, from this rafter, and mark their locations by squaring a line across top plate

   d. Mark an "R" on one side of line to indicate side on which side rafter is to be placed

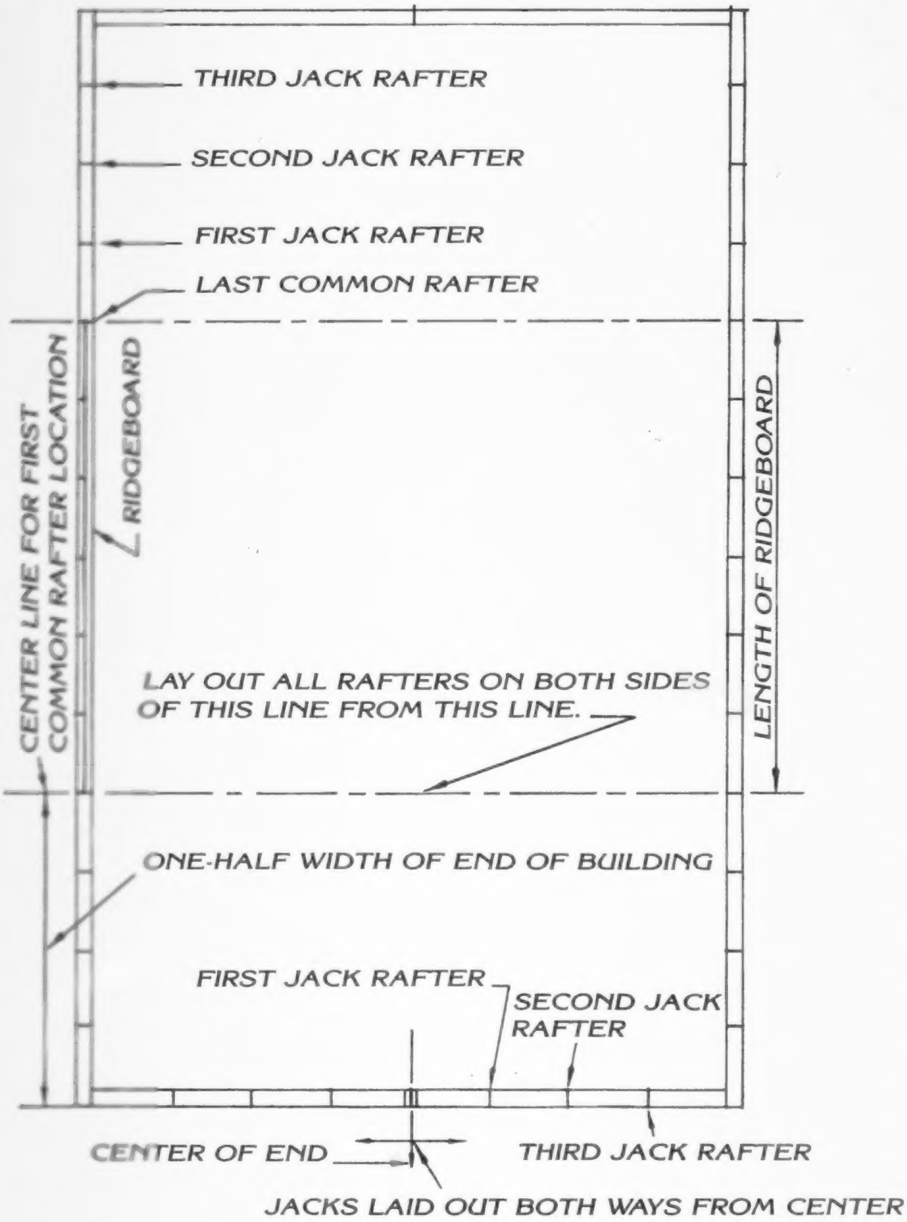
   e. Repeat steps a through d for opposite side

   f. Lay out end wall, beginning at center and working both ways

   g. Transfer top-plate markings to the ridgeboard by holding one edge on top plate with one end flush with outside mark for first common rafter and marking each location on both sides of ridgeboard (See Figure 16)

JOB SHEET #1

FIGURE 16


THIRD JACK RAFTER
SECOND JACK RAFTER
FIRST JACK RAFTER
LAST COMMON RAFTER
CENTER LINE FOR FIRST COMMON RAFTER LOCATION
RIDGEBOARD
LENGTH OF RIDGEBOARD
LAY OUT ALL RAFTERS ON BOTH SIDES OF THIS LINE FROM THIS LINE.
ONE-HALF WIDTH OF END OF BUILDING
FIRST JACK RAFTER
SECOND JACK RAFTER
CENTER OF END
THIRD JACK RAFTER
JACKS LAID OUT BOTH WAYS FROM CENTER

C. Clean up area and put away tools and materials

ROOF FRAMING
UNIT III

JOB SHEET #2 — LAY OUT, CUT, AND ERECT RAFTERS

I. Tools and materials

  A. Framing square

  B. 100-foot tape

  C. Folding rule or steel tape

  D. Claw hammer

  E. Power handsaw and extension cord

  F. Handsaw

  G. Rafter tables booklet

  H. Pencil

  I. Chalk line

  J. String line

  K. Rafter materials

  L. Ridgeboard material

  M. Nails

    1. 16d box nails

    2. 8d box nails

II. Procedure

(NOTE: The procedures described in this job sheet require care and practice. To illustrate calculations, an example will be used throughout the job sheet. The example consists of a structure with an 18-foot span and a 6 in 12 slope. Your instructor may have you construct these rafters for practice or apply the procedures to other rafters.)

  A. Lay out and cut a pattern for each type of rafter needed

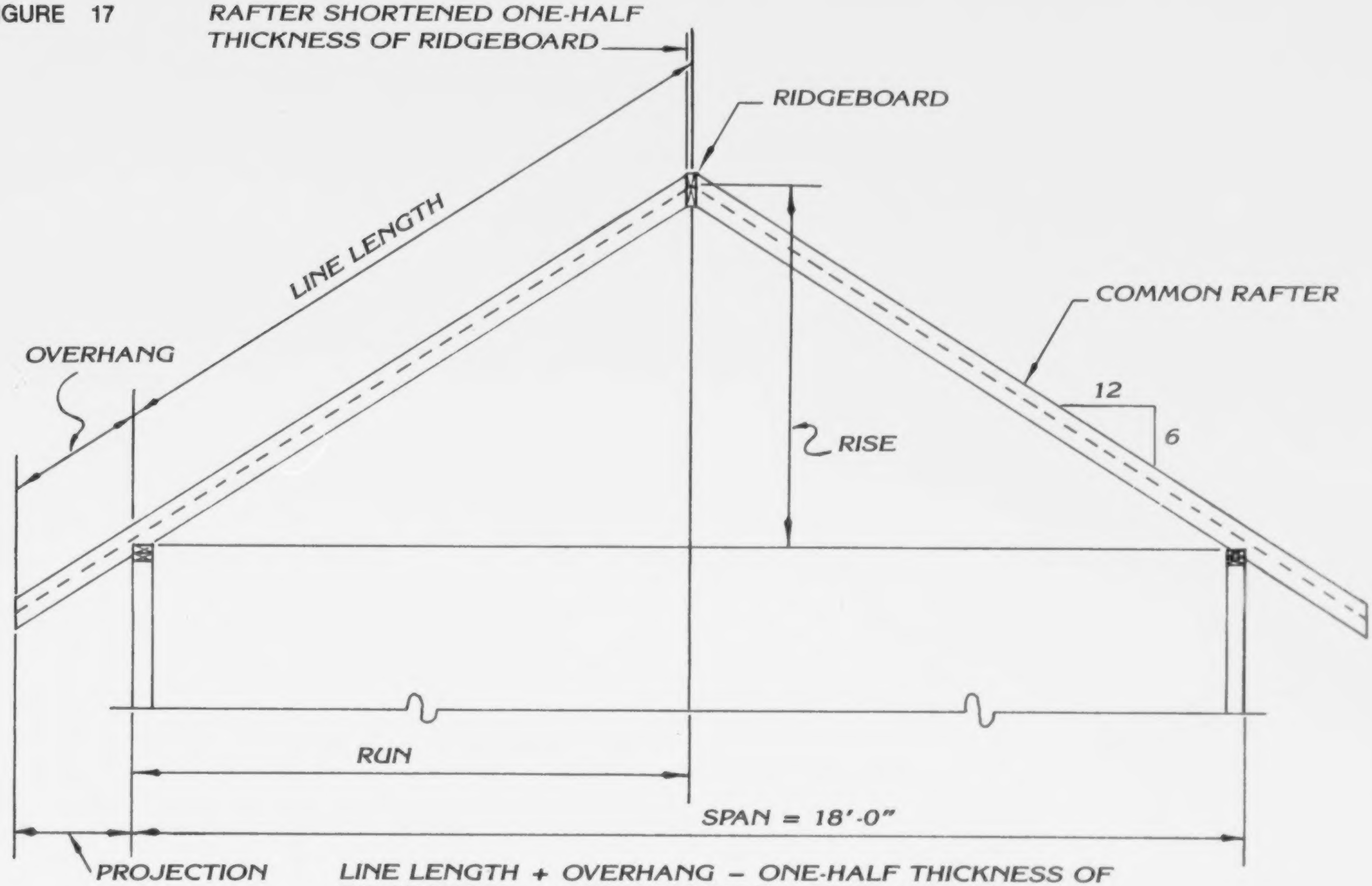
    1. Common rafter

      a. Calculate length of rafter (See Figure 17)

      (NOTE: This length is the center-line length of the rafter. Use framing square or rafter table. See Tables 1 and 2.)

JOB SHEET #2

FIGURE 17


RAFTER SHORTENED ONE-HALF
THICKNESS OF RIDGEBOARD
RIDGEBOARD
LINE LENGTH
COMMON RAFTER
OVERHANG
12
6
RISE
RUN
SPAN = 18'-0"
PROJECTION

LINE LENGTH + OVERHANG − ONE-HALF THICKNESS OF RIDGEBOARD = TRUE COMMON RAFTER LENGTH

JOB SHEET #2

TABLE 1

JACK RAFTER

Spaced In.	Length Ft.	Length In.
1..		1
2..		2⅛
3..		3⅛
4..		4¼
5..		5¼
6..		6⅜
7..		7⅜
8..		8⅜
9..		9½
10..		10½
11..		11⅝
12..	1	0⅝
13..		1¾
14..		2¾
15..		3¾
16..		4⅞
17..		5⅞
18..		7
19..		8
20..		9⅛
21..		10⅛
22..		11¼
23..	2	0¼
24..		1¼
25..		2⅜
26..		3⅜
27..		4½
28..		5½
29..		6⅝
30..		7⅝
31..		8⅝
32..		9¾
33..		10¾
34..		11⅞
35..	3	0⅞
36..		2
37..		3
38..		4
39..		5⅛
40..		6⅛
41..		7¼
42..		8¼
43..		9⅜
44..		10⅜
45..		11⅜
46..	4	0½
47..		1½
48..		2⅝

4-INCH
RISE PER FOOT

EXPLANATION

Common Rafter

Width of building...........31'4¾"
Find length of Common Rafter.

Answer:

Under Span, ft. find 31' = 16' 4"
" " in. " 4¾" = 2½"

Total length Common Rft. 16' 6½"

When rafters overhang, add both overhangs to width of building. Use total span as before.

To get length of rafter by its run: doubling the run gives the span. Proceed as before.

Tables give full length. Allow for half thickness of ridge.

Spans over 50', as 60', add lengths of 50' & 10' spans together.

Hip Rafter

If common rafter span is 31'4¾", Hip rafter is 22'9¾" long. Measure length of Hip on center of top edge. If Hip is unbacked (top edge square), see Index. If edge is backed (beveled), see Index.

Allow for half thickness of ridge.

Jack Rafters

Spaced 28" apart are 2'5½" different in length. Measure length on center of top edge. Cut short equal to half thickness of hip.

CUTS FOR STEEL SQUARE.

The first figure is always the cut.

Common Rafter

Plumb 4 - 12
Level. 12 4

Hip Rafter

Plumb 4 - 17
Level. 17 - 4
Side.. 8¾ - 8½
Backing 4 - 17⅜
Set bevel to last named.

Jack Rafter

Plumb 4 - 12
Level. 12 4
Side.. 12⅝ - 12

Purlin Rafter Roof Sheathing

Plumb 4 - 12⅝
Cross. 12 - 12⅝

Valley Shingles

Cross. 12 - 12⅝
Set bevel on butt end.

Mitre-Box Cuts for Gable Moulds

Plumb 4 - 12
Mitre. 12⅝ - 12

Bisection of
4 - 12 = 3⅞ - 24

For full explanation see Index.

COMMON RAFTER

Span Ft.	Length Ft.	Length In.	Span In.	Lgth. In.
1..		6⅜	¼..	⅛
2..	1.	0⅝	½..	¼
3..	1.	7	¾..	⅜
4..	2.	1¼	1 ..	½
5..	2.	7⅝	¼..	⅝
6..	3.	2	½..	¾
7..	3.	8¼	¾..	⅞
8..	4.	2⅝	2 ..	1
9..	4.	8⅞	¼..	⅛
10..	5.	3¼	½..	⅜
11..	5.	9⅝	¾..	½
12..	6.	3⅞	3 ..	⅝
13..	6.	10¼	¼..	¾
14..	7.	4½	½..	⅞
15..	7.	10⅞	¾..	2
16..	8.	5¼	4 ..	⅛
17..	8.	11½	¼..	¼
18..	9.	5⅞	½..	⅜
19..	10.	0⅛	¾..	½
20..	10.	6½	5 ..	⅝
21..	11.	0⅞	¼..	¾
22..	11.	7⅛	½..	⅞
23..	12.	1½	¾..	3
24..	12.	7¾	6 ..	⅛
25..	13.	2⅛	¼..	¼
26..	13.	8½	½..	⅜
27..	14.	2¾	¾..	½
28..	14.	9⅛	7 ..	¾
29..	15.	3⅜	¼..	⅞
30..	15.	9¾	½..	4
31..	16.	4	¾..	⅛
32..	16.	10⅜	8 ..	¼
33..	17.	4¾	¼..	⅜
34..	17.	11	½..	½
35..	18.	5⅜	¾..	⅝
36..	18.	11⅝	9 ..	¾
37..	19.	6	¼..	⅞
38..	20.	0⅜	½..	5
39..	20.	6⅝	¾..	⅛
40..	21.	1	10 ..	¼
41..	21.	7¼	¼..	⅜
42..	22.	1⅝	½..	½
43..	22.	8	¾..	⅝
44..	23.	2¼	11 ..	¾
45..	23.	8⅝	¼..	⅞
46..	24.	3	½..	6
47..	24.	9¼	¾..	¼
48..	25.	3⅝	12 ..	⅜
49..	25.	9⅞		
50..	26.	4¼		

HIP OR VALLEY RAFTER

Span Ft.	Length Ft.	Length In.	Span In.	Lgth. In.
1..		8¾	¼..	⅛
2..	1.	5⅜	½..	⅜
3..	2.	2⅛	¾..	½
4..	2.	10⅞	1 ..	¾
5..	3.	7⅝	¼..	⅞
6..	4.	4¼	½..	1⅛
7..	5.	1	¾..	¼
8..	5.	9¾	2 ..	½
9..	6.	6½	¼..	⅝
10..	7.	3⅛	½..	⅞
11..	7.	11⅞	¾..	2
12..	8.	8⅝	3 ..	⅛
13..	9.	5⅜	¼..	⅜
14..	10.	2	½..	½
15..	10.	10¾	¾..	¾
16..	11.	7½	4 ..	⅞
17..	12.	4¼	¼..	3⅛
18..	13.	0⅞	½..	¼
19..	13.	9⅝	¾..	½
20..	14.	6⅜	5 ..	⅝
21..	15.	3⅛	¼..	⅞
22..	15.	11¾	½..	4
23..	16.	8½	¾..	⅛
24..	17.	5¼	6 ..	⅜
25..	18.	2	¼..	½
26..	18.	10⅝	½..	¾
27..	19.	7⅜	¾..	⅞
28..	20.	4⅛	7 ..	5⅛
29..	21.	0⅞	¼..	¼
30..	21.	9½	½..	½
31..	22.	6¼	¾..	⅝
32..	23.	3	8 ..	¾
33..	23.	11¾	¼..	6
34..	24.	8⅜	½..	⅛
35..	25.	5⅛	¾..	⅜
36..	26.	1⅞	9 ..	½
37..	26.	10½	¼..	¾
38..	27.	7¼	½..	⅞
39..	28.	4	¾..	7⅛
40..	29.	0¾	10 ..	¼
41..	29.	9⅜	¼..	½
42..	30.	6⅛	½..	⅝
43..	31.	2⅞	¾..	¾
44..	31.	11⅝	11 ..	8
45..	32.	8¼	¼..	⅛
46	33.	5	½..	⅜
47..	34.	1¾	¾..	½
48..	34.	10½	12 ..	¾
49..	35.	7⅛		
50..	36.	3⅞		

Used with permssion of A.F.J. Riechers, *Full-Length Roof Framer*, copyright 1944.

JOB SHEET #2

TABLE 2

JACK RAFTER

Spaced In.	Length Ft.	Length In.
1		1⅛
2		2¼
3		3⅜
4		4½
5		5⅝
6		6¾
7		7⅞
8		9
9		10⅛
10		11⅛
11	1	0¼
12		1⅜
13		2½
14		3⅝
15		4¾
16		5⅞
17		7
18		8⅛
19		9¼
20		10⅜
21		11½
22	2	0⅝
23		1¾
24		2⅞
25		4
26		5⅛
27		6⅛
28		7¼
29		8⅜
30		9½
31		10⅝
32		11¾
33	3	0⅞
34		2
35		3⅛
36		4¼
37		5⅜
38		6½
39		7⅝
40		8¾
41		9⅞
42		11
43	4	0⅛
44		1¼
45		2¼
46		3⅜
47		4½
48		5⅝

6-INCH RISE PER FOOT

EXPLANATION

Common Rafter

Width of building...........24'6¼"
Find length of Common Rafter.

Answer:

Under **Span, ft.** find 24' = 13' 5"
" " **In.** " 6¼" = 3½"

Total length Common Rft. 13' 8½"

When rafters overhang, add both overhangs to width of building. Use total span as before.

To get length of rafter by its run: doubling the run gives the span. Proceed as before.

Tables give full length. Allow for half thickness of ridge.

Spans over 50', as 60', add lengths of 50' & 10' spans together.

Hip Rafter

If common rafter span is 24'6¼", Hip rafter is 18'4⅝" long. Measure length of Hip on center of top edge. If Hip is unbacked (top edge square), see Index. If edge is backed (beveled), see Index.

Allow for half thickness of ridge.

Jack Rafters

Spaced 24" apart are 2'2⅞" different in length. Measure length on center of top edge. Cut short equal to half thickness of hip.

CUTS FOR STEEL SQUARE.

The first figure is always the cut.

Common Rafter

Plumb 6 - 12
Level. 12 - 6

Hip Rafter

Plumb 6 - 17
Level. 17 - 6
Side.. 9 - 8½
Backing 6 - 18
Set bevel to last named.

Jack Rafter

Plumb 6 - 12
Level. 12 - 6
Side.. 13⅜- 12

Purlin Rafter Roof Sheathing

Plumb 6 - 13⅜
Cross. 12 - 13⅜

Valley Shingles

Cross. 12 - 13⅜
Set bevel on butt end.

Mitre-Box Cuts for Gable Moulds

Plumb 6 - 12
Mitre. 13⅜- 12

Bisection of
6- 12=5⅝- 24

For full explanation see Index.

COMMON RAFTER

Span Ft.	Length Ft.	Length In.	Span In.	Lgth. In.
1		6¾	¼	⅛
2	1	1⅜	½	¼
3	1	8⅛	¾	⅜
4	2	2⅞	1	½
5	2	9½	¼	¾
6	3	4¼	½	⅞
7	3	11	¾	1
8	4	5⅝	2	⅛
9	5	0⅜	¼	¼
10	5	7⅛	½	⅜
11	6	1¾	¾	½
12	6	8½	3	⅝
13	7	3¼	¼	⅞
14	7	9⅞	½	2
15	8	4⅝	¾	⅛
16	8	11⅜	4	¼
17	9	6	¼	⅜
18	10	0¾	½	½
19	10	7½	¾	⅝
20	11	2⅛	5	¾
21	11	8⅞	¼	⅞
22	12	3⅝	½	3⅛
23	12	10¼	¾	¼
24	13	5	6	⅜
25	13	11¾	¼	½
26	14	6⅜	½	⅝
27	15	1⅛	¾	¾
28	15	7⅞	7	⅞
29	16	2½	¼	4
30	16	9¼	½	¼
31	17	4	¾	⅜
32	17	10⅝	8	½
33	18	5⅜	¼	⅝
34	19	0⅛	½	¾
35	19	6¾	¾	⅞
36	20	1½	9	5
37	20	8¼	¼	⅛
38	21	2⅞	½	¼
39	21	9⅝	¾	½
40	22	4⅜	10	⅝
41	22	11	¼	¾
42	23	5¾	½	⅞
43	24	0½	¾	6
44	24	7⅛	11	⅛
45	25	1⅞	¼	¼
46	25	8⅝	½	⅜
47	26	3¼	¾	½
48	26	10	12	¾
49	27	4¾		
50	27	11⅜		

HIP OR VALLEY RAFTER

Span Ft.	Length Ft.	Length In.	Span In.	Lgth. In.
1		9	¼	¼
2	1	6	½	⅜
3	2	3	¾	⅝
4	3	0	1	¾
5	3	9	¼	1
6	4	6	½	⅛
7	5	3	¾	¼
8	6	0	2	½
9	6	9	¼	⅝
10	7	6	½	⅞
11	8	3	¾	2
12	9	0	3	¼
13	9	9	¼	⅜
14	10	6	½	⅝
15	11	3	¾	¾
16	12	0	4	3
17	12	9	¼	⅛
18	13	6	½	⅜
19	14	3	¾	½
20	15	0	5	¾
21	15	9	¼	⅞
22	16	6	½	4⅛
23	17	3	¾	¼
24	18	0	6	½
25	18	9	¼	⅝
26	19	6	½	⅞
27	20	3	¾	5
28	21	0	7	¼
29	21	9	¼	⅜
30	22	6	½	⅝
31	23	3	¾	¾
32	24	0	8	6
33	24	9	¼	⅛
34	25	6	½	⅜
35	26	3	¾	½
36	27	0	9	¾
37	27	9	¼	⅞
38	28	6	½	7⅛
39	29	3	¾	¼
40	30	0	10	½
41	30	9	¼	⅝
42	31	6	½	⅞
43	32	3	¾	8
44	33	0	11	¼
45	33	9	¼	⅜
46	34	6	½	⅝
47	35	3	¾	¾
48	36	0	12	9
49	36	9		
50	37	6		

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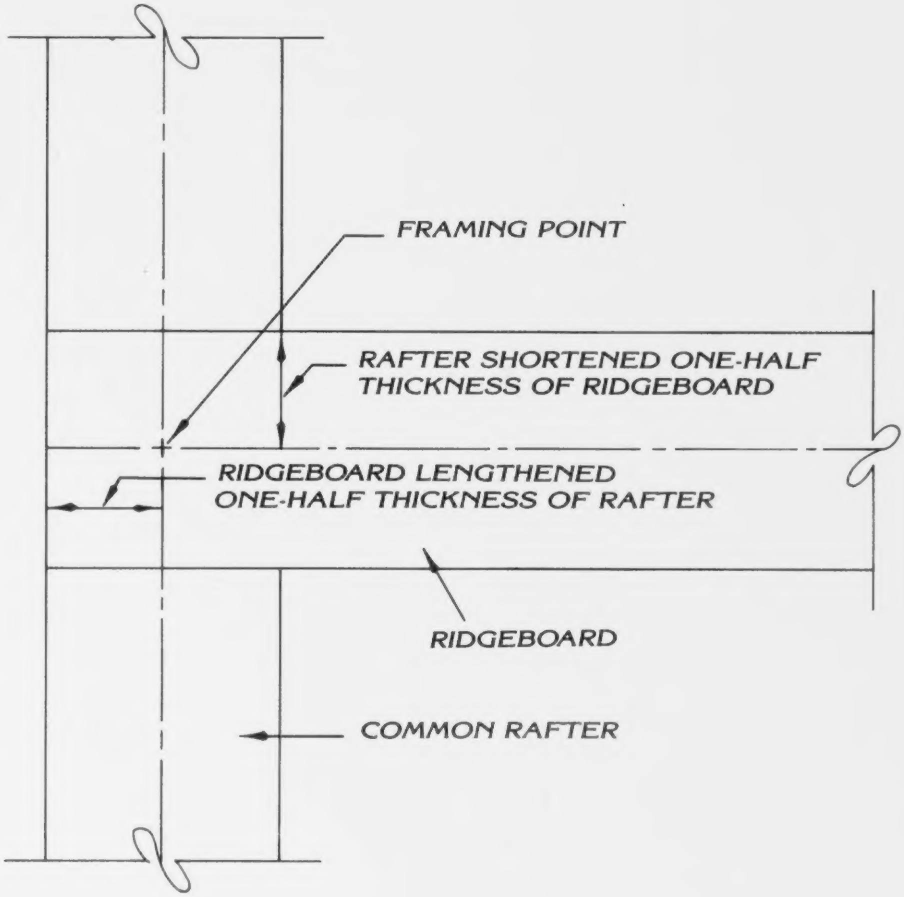
JOB SHEET #2

b. Shorten length of rafter by one-half thickness of ridgeboard (Figure 18)

FIGURE 18


FRAMING POINT
RAFTER SHORTENED ONE-HALF THICKNESS OF RIDGEBOARD
RIDGEBOARD LENGTHENED ONE-HALF THICKNESS OF RAFTER
RIDGEBOARD
COMMON RAFTER

c. Lay a 2×6, sufficient in length for a common rafter including overhang, across two sawhorses

d. Mark top end or plumb cut

   1) Determine crown edge of rafter

   2) Make sure toe of plumb cut is on crown edge

   3) Place framing square across face of rafter near one end with blade running lengthwise with rafter and tongue running across face of rafter

JOB SHEET #2

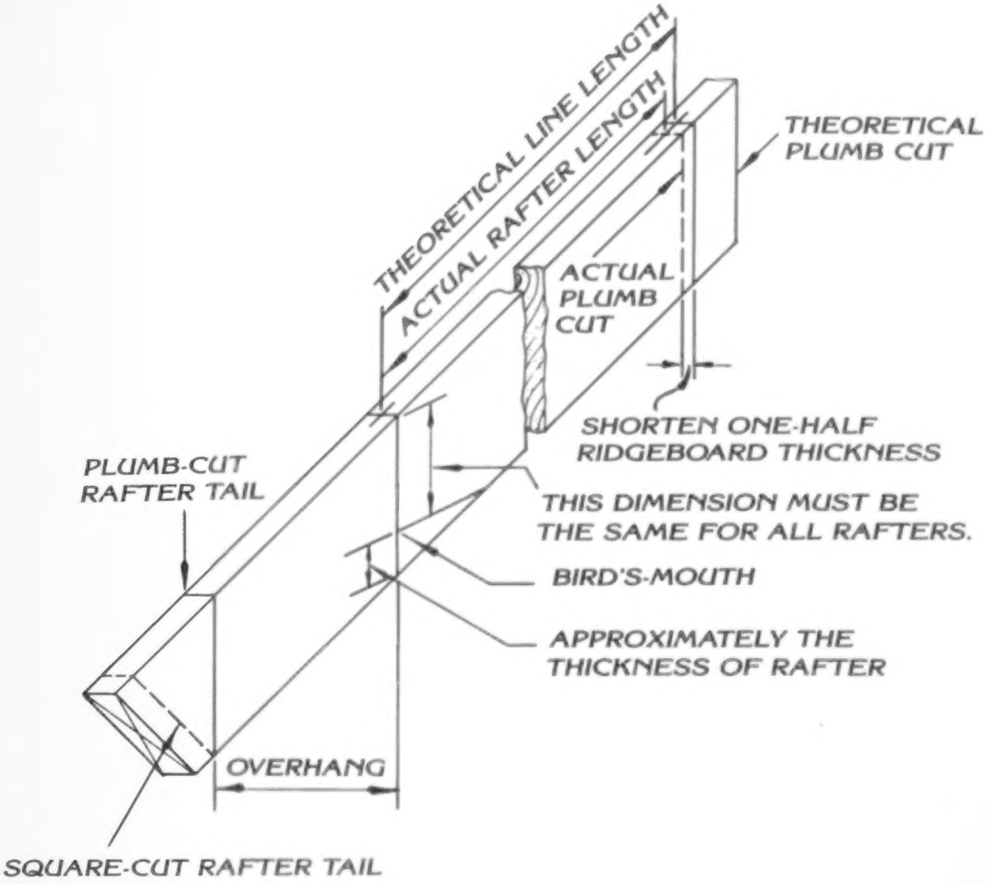
4) Locate inches of rise per foot of run on tongue of framing square

5) Locate inches of run on blade of framing square

(NOTE: For common rafter, the run will always be 12 inches.)

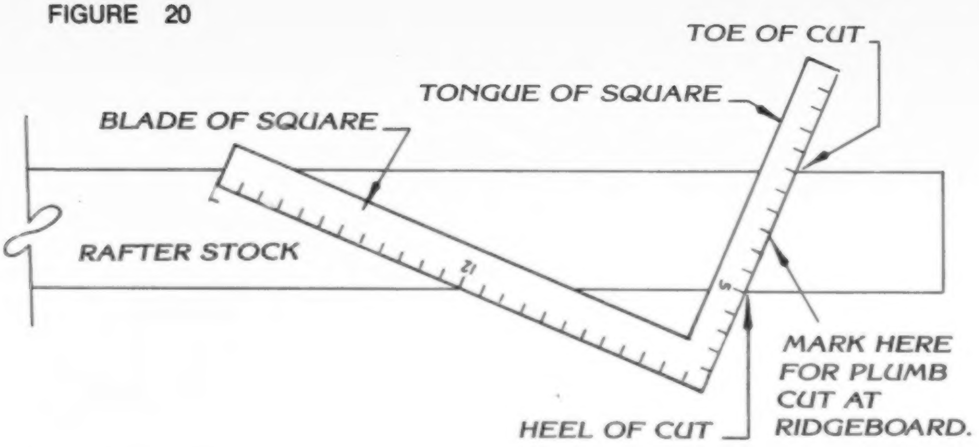
6) Mark rafter on outside edge of framing-square tongue (Figures 19 and 20)

FIGURE 19


THEORETICAL LINE LENGTH
ACTUAL RAFTER LENGTH
THEORETICAL PLUMB CUT
ACTUAL PLUMB CUT
SHORTEN ONE-HALF RIDGEBOARD THICKNESS
PLUMB-CUT RAFTER TAIL
THIS DIMENSION MUST BE THE SAME FOR ALL RAFTERS.
BIRD'S-MOUTH
APPROXIMATELY THE THICKNESS OF RAFTER
OVERHANG
SQUARE-CUT RAFTER TAIL

JOB SHEET #2

FIGURE 20


TOE OF CUT
TONGUE OF SQUARE
BLADE OF SQUARE
RAFTER STOCK
12
5
MARK HERE FOR PLUMB CUT AT RIDGEBOARD.
HEEL OF CUT

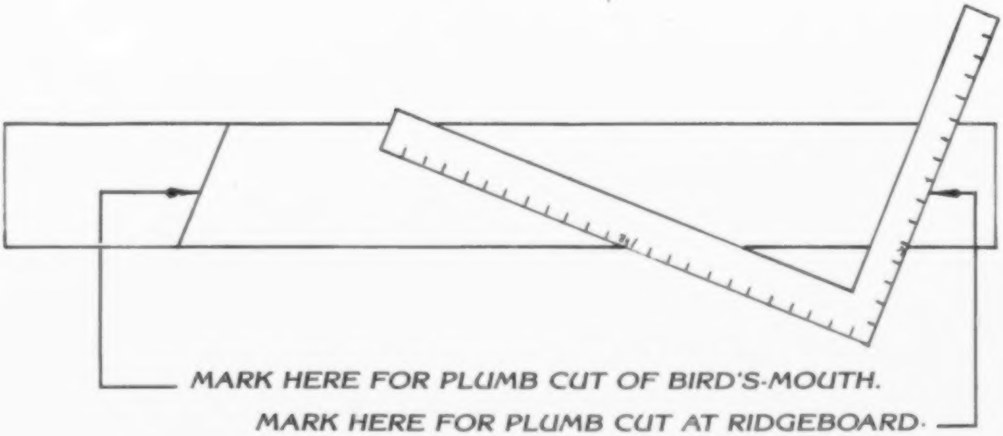
7) Using 18′-0″ span of structure, determine from rafter table line length of rafter

e. Measure length of rafter on top edge from toe of plumb cut

f. Place framing square in position to mark plumb cut for bird's-mouth, and mark 1½-inch line (Figure 21)

(NOTE: Adjustment may need to be made for high-pitch roofs.)

FIGURE 21

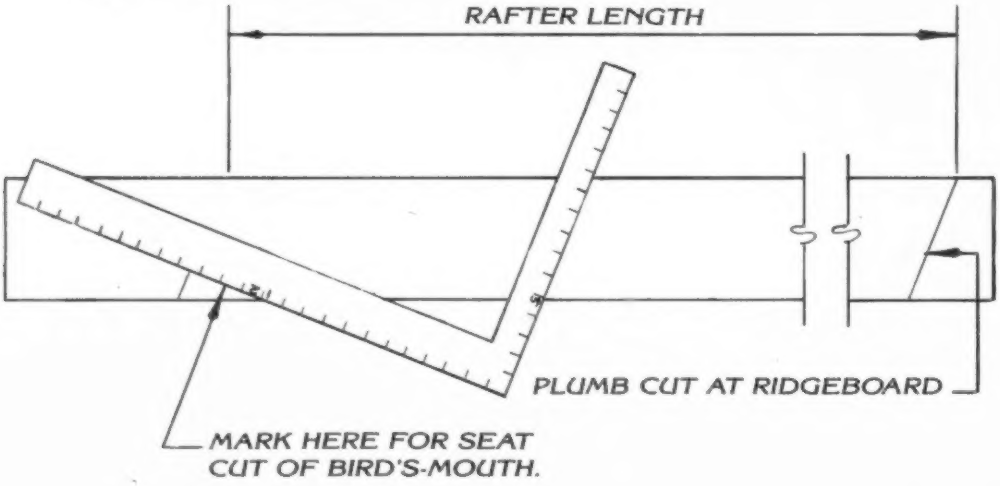

12
5
MARK HERE FOR PLUMB CUT OF BIRD'S-MOUTH.
MARK HERE FOR PLUMB CUT AT RIDGEBOARD.

JOB SHEET #2

g. Place framing square in position to mark seat cut for bird's-mouth, and mark (Figure 22)

(NOTE: Bird's-mouth cut should not exceed more than one-third of material.)

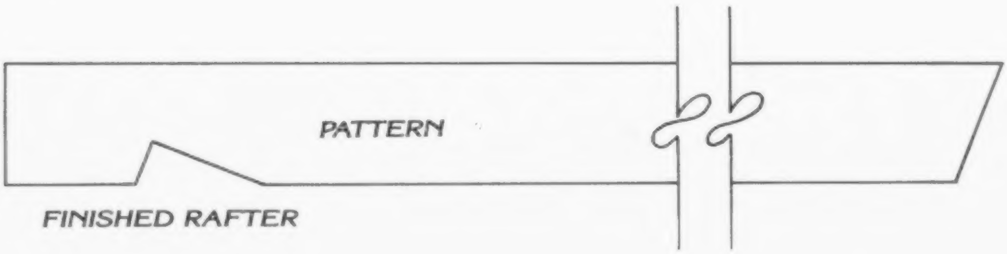
FIGURE 22


RAFTER LENGTH
PLUMB CUT AT RIDGEBOARD
MARK HERE FOR SEAT CUT OF BIRD'S-MOUTH.

h. Cut rafter on lines marked

(NOTE: Cut only part of the bird's-mouth with the power saw; finish the cut with a handsaw. The finished rafter should look like the one in Figure 23. Care must be taken to get a very accurate cut on the first rafter, as it will be used as a pattern for the remaining common rafters. Write "Pattern" on both sides. See Figure 23. When using pattern rafter, keep top flush at bird's-mouth when marking.)

FIGURE 23


PATTERN
FINISHED RAFTER

JOB SHEET #2

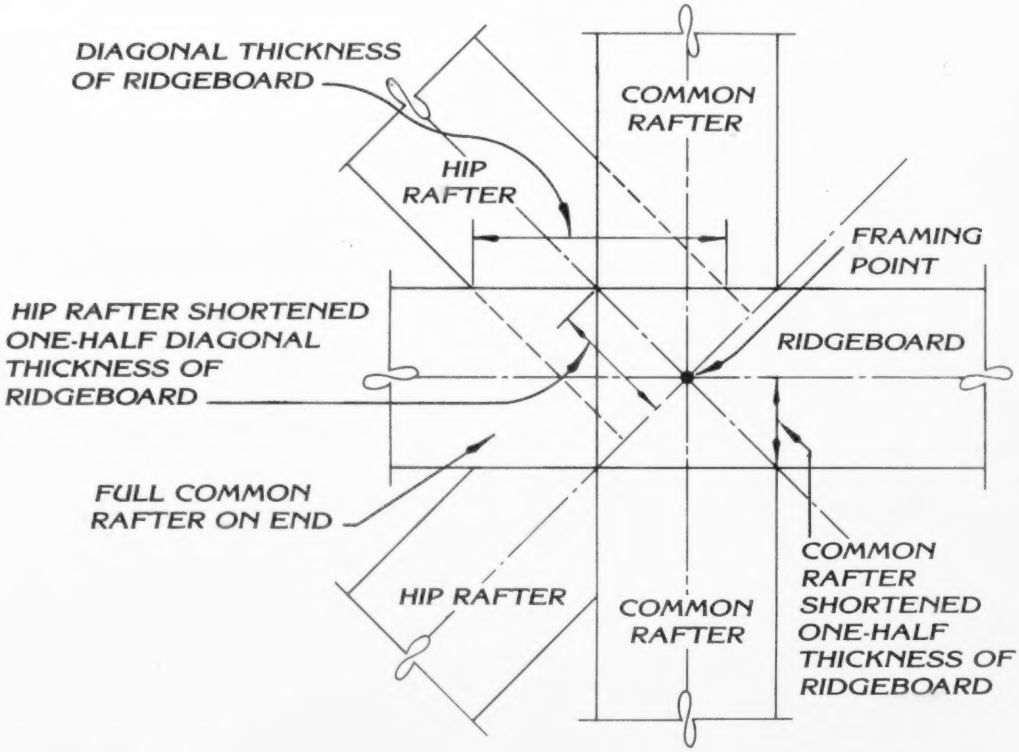
2. Hip or valley rafter

   a. Determine length of rafters

      (NOTE: Rafter length can be determined by measurement; this length is the center-line length of rafter.)

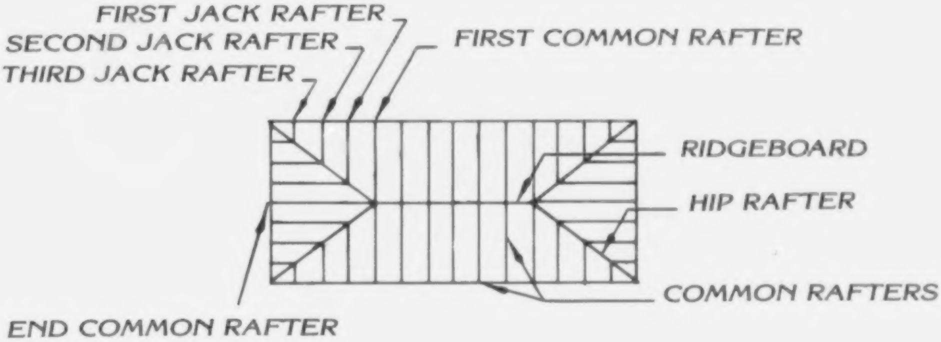
   b. Shorten length of rafter by one-half the diagonal thickness of ridgeboard to allow for ridgeboard (See Figures 24 and 25)

FIGURE 24


DIAGONAL THICKNESS OF RIDGEBOARD
COMMON RAFTER
HIP RAFTER
FRAMING POINT
HIP RAFTER SHORTENED ONE-HALF DIAGONAL THICKNESS OF RIDGEBOARD
RIDGEBOARD
FULL COMMON RAFTER ON END
HIP RAFTER
COMMON RAFTER
COMMON RAFTER SHORTENED ONE-HALF THICKNESS OF RIDGEBOARD

JOB SHEET #2

FIGURE 25


FIRST JACK RAFTER
SECOND JACK RAFTER
THIRD JACK RAFTER
FIRST COMMON RAFTER
RIDGEBOARD
HIP RAFTER
COMMON RAFTERS
END COMMON RAFTER

c. Lay a 2×8, sufficient in length for a hip rafter including overhang, across two sawhorses; lay out and cut as for common rafter (Figures 26 and 27)

(NOTE: The inches of run on the blade of the framing square for a hip rafter will always be seventeen. See example.)

EXAMPLE:

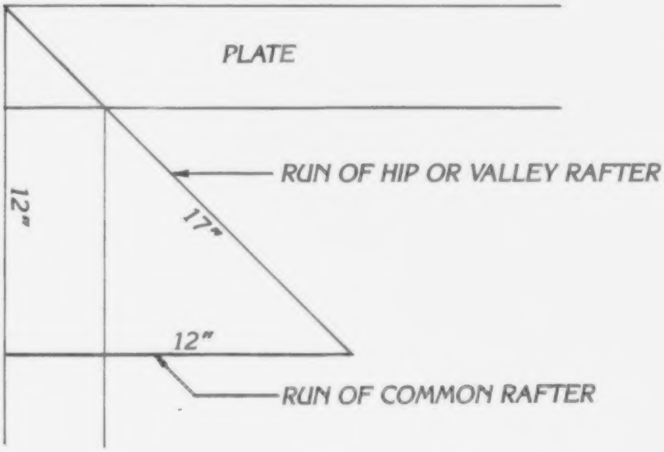


PLATE
RUN OF HIP OR VALLEY RAFTER
12"
17"
12"
RUN OF COMMON RAFTER

JOB SHEET #2

FIGURE 26

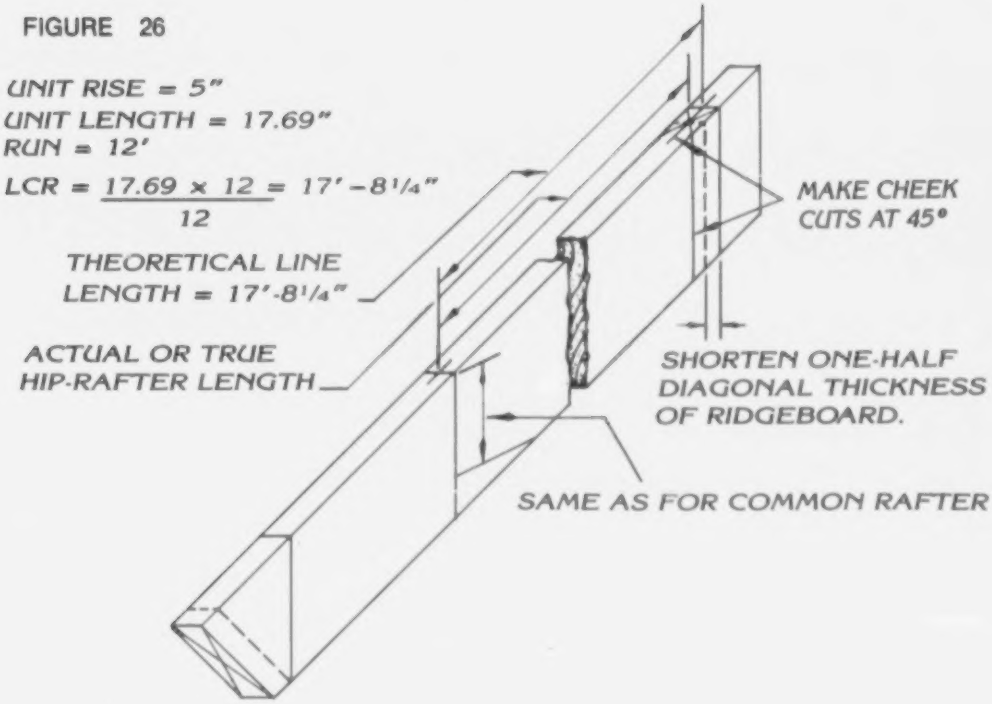
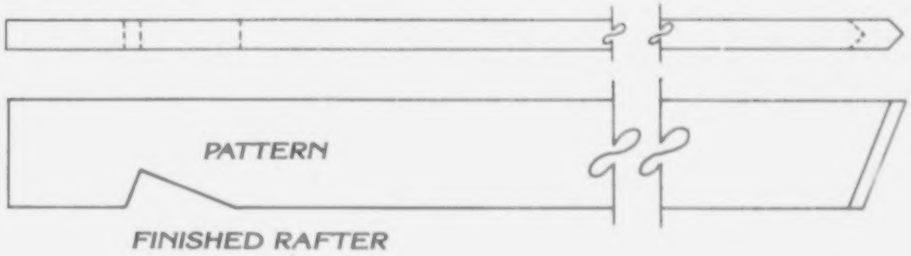

UNIT RISE = 5"
UNIT LENGTH = 17.69"
RUN = 12'
LCR = 17.69 × 12 / 12 = 17'-8¼"
THEORETICAL LINE LENGTH = 17'-8¼"
ACTUAL OR TRUE HIP-RAFTER LENGTH
MAKE CHEEK CUTS AT 45°
SHORTEN ONE-HALF DIAGONAL THICKNESS OF RIDGEBOARD.
SAME AS FOR COMMON RAFTER

FIGURE 27


PATTERN
FINISHED RAFTER

d. Cut valley rafters as for hip rafters except that bird's-mouth will be raised $^3/_8$-inch

3. Hip or valley jack rafters on 2-foot centers

   a. Determine length of first jack rafter

      (NOTE: Remember that the figure read from the framing square is the difference in length of jack rafters from the common rafter.)

JOB SHEET #2

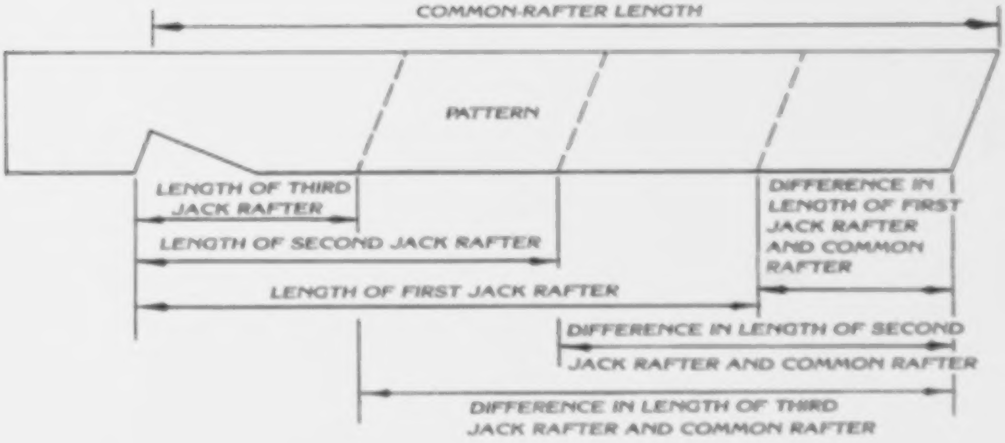
b. Use pattern for common rafters to mark bird's-mouth

(NOTE: Drop the hip 3/8 inch to align with common rafter and raise 3/8 inch on valley rafters.)

c. Measure length of first jack rafter from plumb cut of bird's-mouth (Figures 28 and 29)

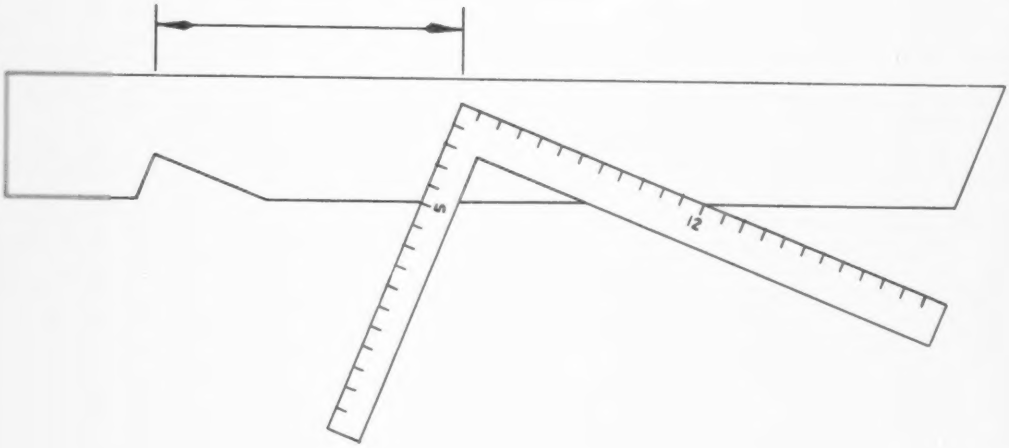
(NOTE: Remember that this length is the theoretical length of the jack rafter and it must be shortened one-half the diagonal thickness of the rafter.)

FIGURE 28


COMMON-RAFTER LENGTH
PATTERN
LENGTH OF THIRD JACK RAFTER
LENGTH OF SECOND JACK RAFTER
LENGTH OF FIRST JACK RAFTER
DIFFERENCE IN LENGTH OF FIRST JACK RAFTER AND COMMON RAFTER
DIFFERENCE IN LENGTH OF SECOND JACK RAFTER AND COMMON RAFTER
DIFFERENCE IN LENGTH OF THIRD JACK RAFTER AND COMMON RAFTER

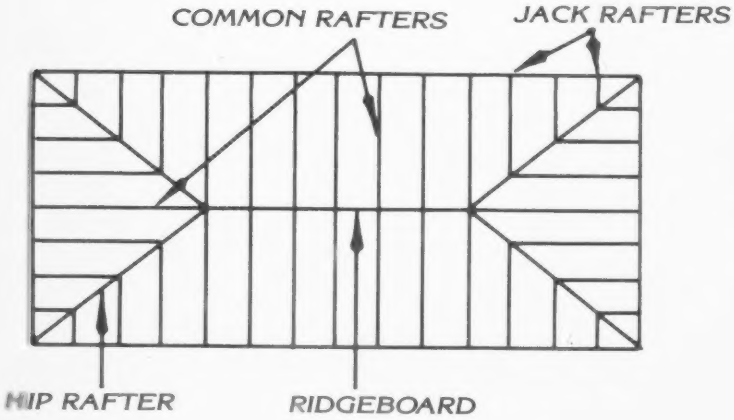
JOB SHEET #2

FIGURE 29



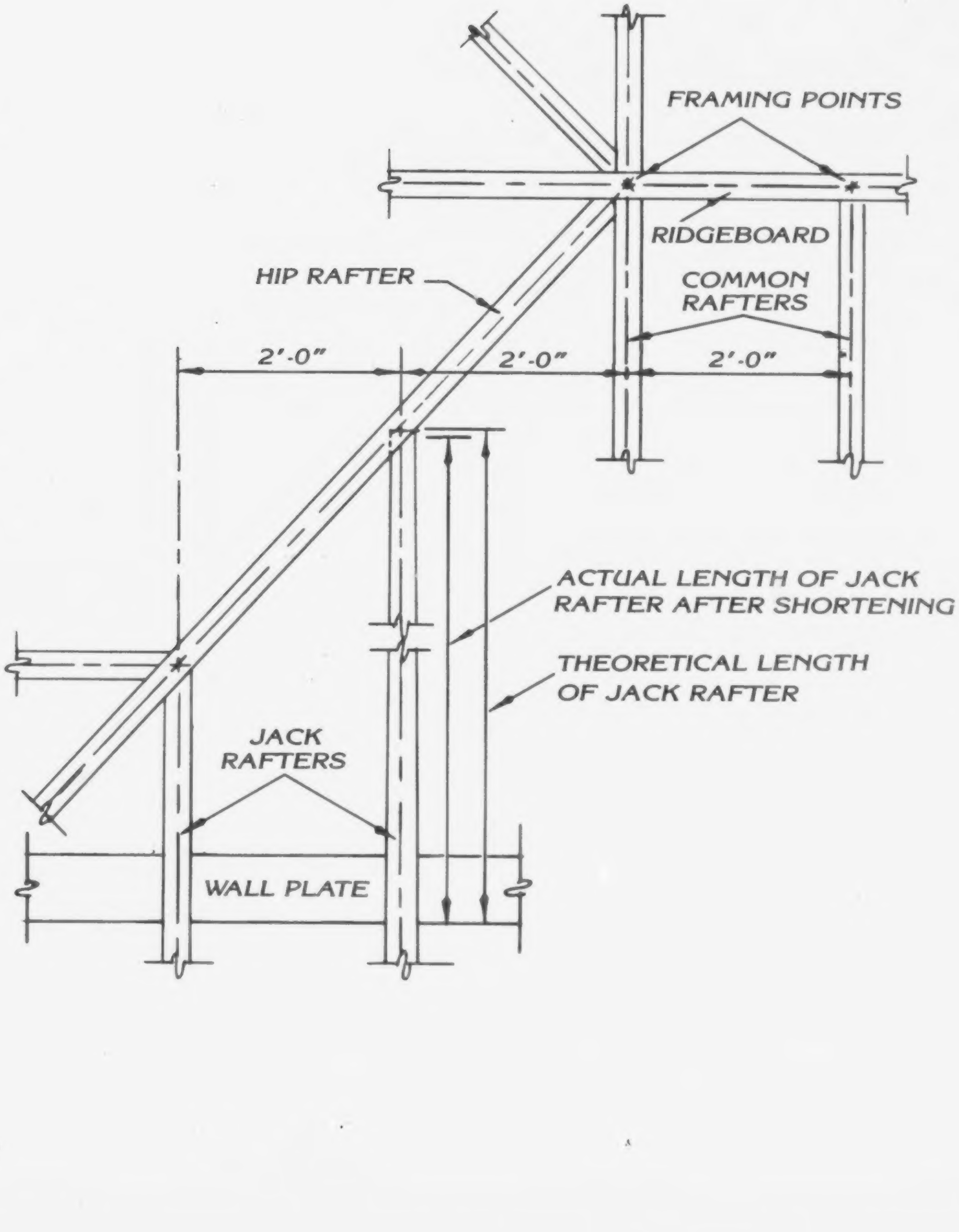
d. Shorten rafter (Figures 30 and 31)

FIGURE 30


COMMON RAFTERS
JACK RAFTERS
HIP RAFTER
RIDGEBOARD

JOB SHEET #2

FIGURE 31

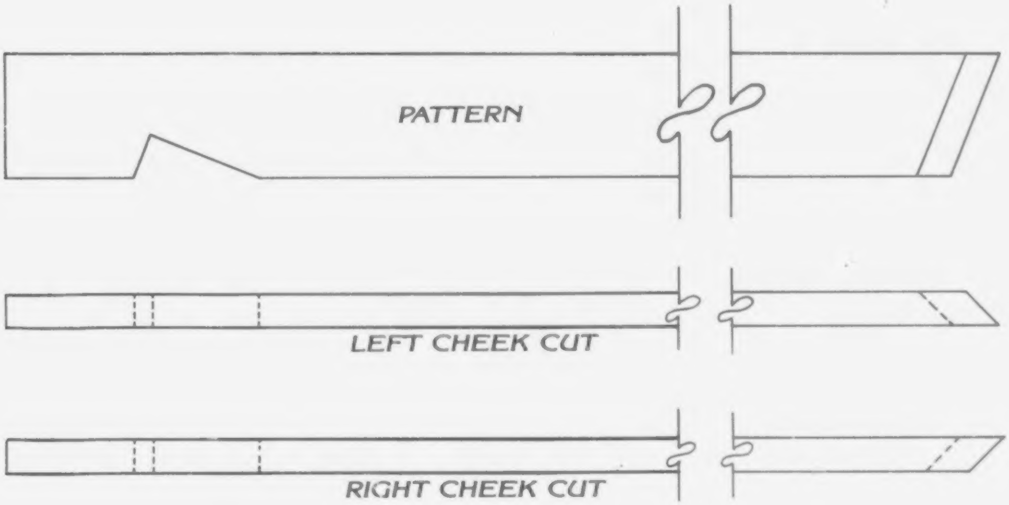

FRAMING POINTS
RIDGEBOARD
HIP RAFTER
COMMON RAFTERS
2'-0"
2'-0"
2'-0"
ACTUAL LENGTH OF JACK RAFTER AFTER SHORTENING
THEORETICAL LENGTH OF JACK RAFTER
JACK RAFTERS
WALL PLATE

JOB SHEET #2

e. Lay out and cut all jack rafters (Figure 32)

(NOTE: For every jack rafter with a cheek cut on the left, there must be one of equal length with a cheek cut on the right.)

FIGURE 32



B. Erect rafters

(NOTE: For simplification, ceiling joists are not shown in the following illustrations.)

1. Gable roof

CAUTION

Place boards across ceiling joists to walk on.

a. Lean all rafters against sides of structure at each rafter location mark, with ridgeboard plumb cut up

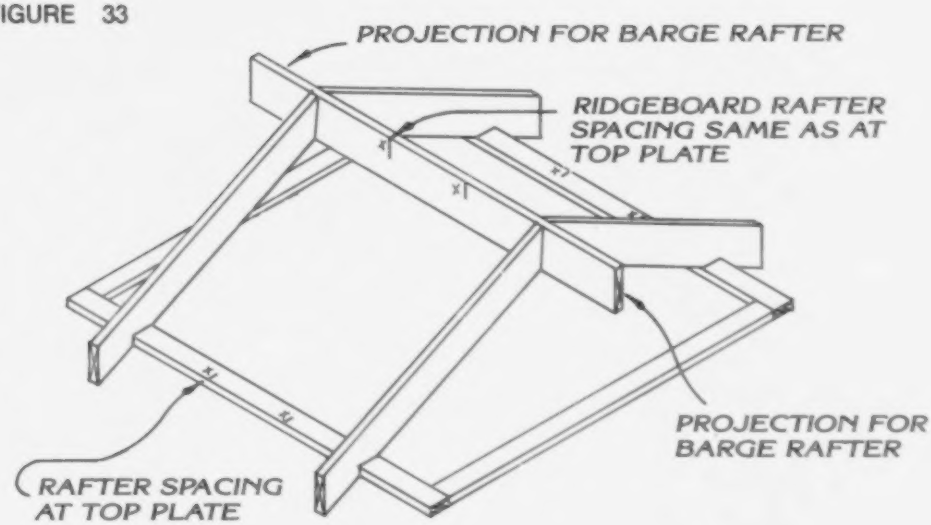
b. Erect and plumb rafter at second rafter location marked on top plate, nailing with 16d box nails through the ridgeboard into rafter (See Figure 33)

c. Nail rafter on opposite side

(NOTE: Be sure that the tops of all rafters are flush with the top of the ridgeboard and inside the marks on the ridgeboard.)

JOB SHEET #2

FIGURE 33


PROJECTION FOR BARGE RAFTER
RIDGEBOARD RAFTER SPACING SAME AS AT TOP PLATE
PROJECTION FOR BARGE RAFTER
RAFTER SPACING AT TOP PLATE

d. Toenail seat of bird's-mouth cut to plate, using 16d box nails

(NOTE: Be sure that the plumb cut of the bird's-mouth is snugged up to the outside of the top plate. Use a temporary brace to hold the ridgeboard up until the nailing is accomplished.)

e. Erect remaining common rafters

(NOTE: Keep the ridgeboard straight. To accomplish this, erect opposing pairs and stretch a string along the top of the center of the ridgeboard as a guide.)

f. Erect end rafters; plumb and brace

g. Frame gable end

(NOTE: See Job Sheet #3.)

2. Hip roof

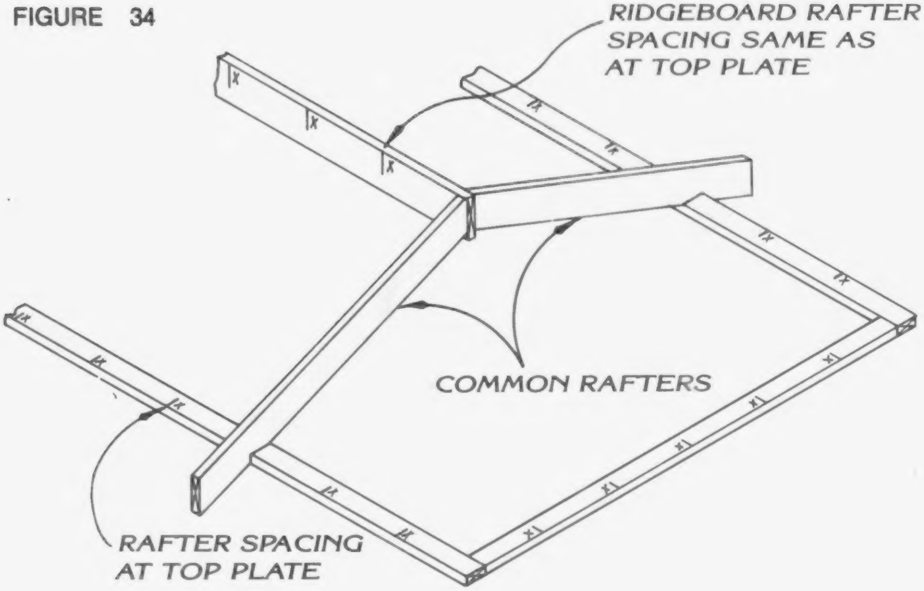
CAUTION
Place boards across ceiling joists to walk on.

a. Lean all rafters against sides of structure at each rafter location mark, with ridgeboard plumb cut up

b. Erect end common rafters on sides (See Figure 34)

JOB SHEET #2

FIGURE 34


RIDGEBOARD RAFTER SPACING SAME AS AT TOP PLATE
COMMON RAFTERS
RAFTER SPACING AT TOP PLATE
X

1) Nail through ridgeboard into end of rafters with 16d box nails

(NOTE: Be sure that tops of all rafters are flush with top of ridgeboard.)

2) Toenail seat of bird's-mouth cut to top plate with 16d box nails

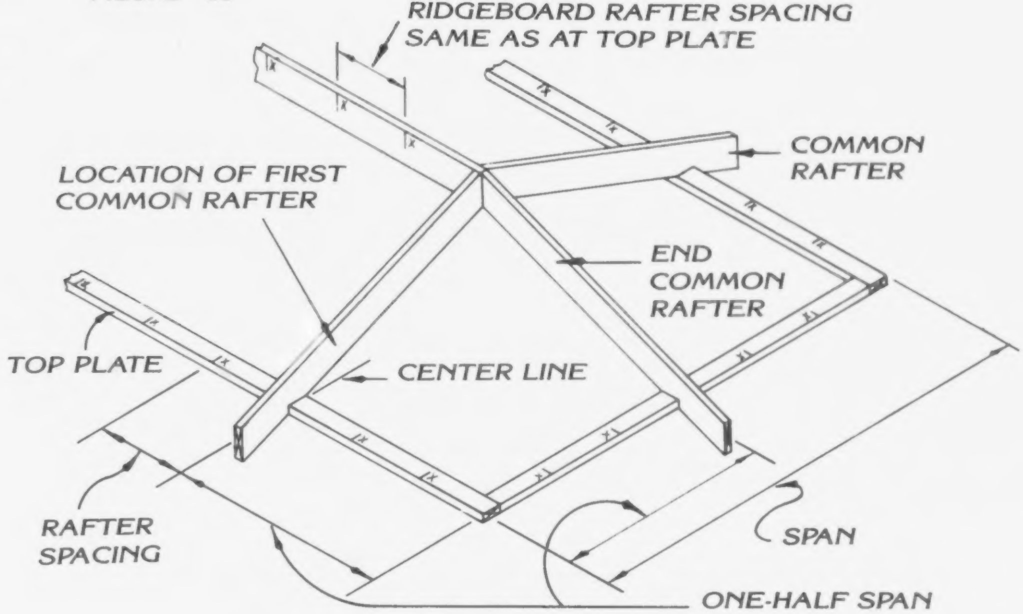
(NOTE: Be sure that the plumb cut of the bird's-mouth is snugged up to the outside of the top plate.)

c. Erect end common rafters, toenailing into ridgeboard and into top plate (See Figure 35)

(NOTE: Be sure that the top of the rafters are flush with the top of the ridgeboard and that the plumb cut of the bird's-mouth is snug to the outside of the top plate.)

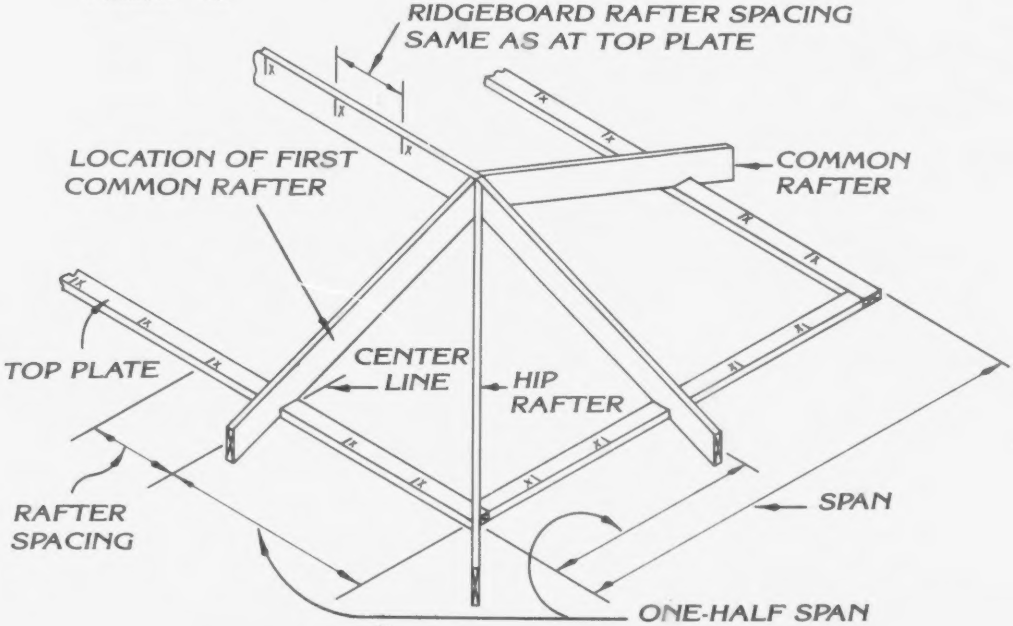
JOB SHEET #2

FIGURE 35


RIDGEBOARD RAFTER SPACING
SAME AS AT TOP PLATE
COMMON
RAFTER
LOCATION OF FIRST
COMMON RAFTER
END
COMMON
RAFTER
TOP PLATE
CENTER LINE
RAFTER
SPACING
SPAN
ONE-HALF SPAN

d. Erect hip rafters (Figure 36)

FIGURE 36


RIDGEBOARD RAFTER SPACING
SAME AS AT TOP PLATE
LOCATION OF FIRST
COMMON RAFTER
COMMON
RAFTER
CENTER
LINE
HIP
RAFTER
TOP PLATE
RAFTER
SPACING
SPAN
ONE-HALF SPAN

e. Erect hip jack rafters

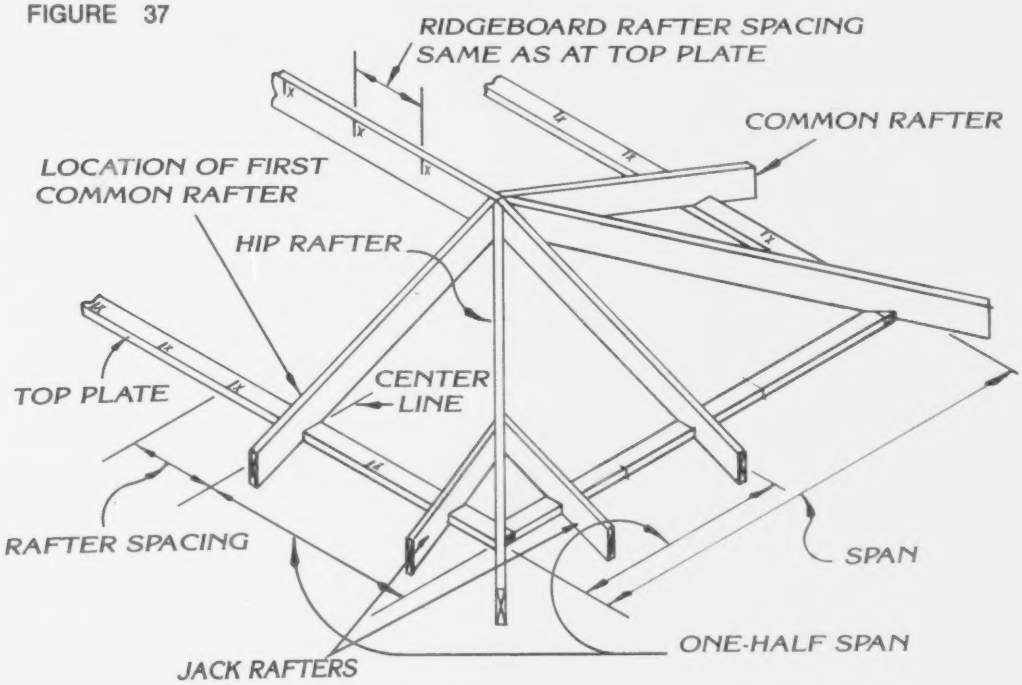
JOB SHEET #2

1) Proceed from longest to shortest rafter

2) Do both sides of hip at same time (Figure 37)

(NOTE: Nail through the jack rafter into the hip rafter at the cheek with 8d box nails. Be sure to keep the top of the hip in a straight line from top to bottom.)

FIGURE 37


RIDGEBOARD RAFTER SPACING SAME AS AT TOP PLATE
COMMON RAFTER
LOCATION OF FIRST COMMON RAFTER
HIP RAFTER
CENTER LINE
TOP PLATE
RAFTER SPACING
SPAN
ONE-HALF SPAN
JACK RAFTERS

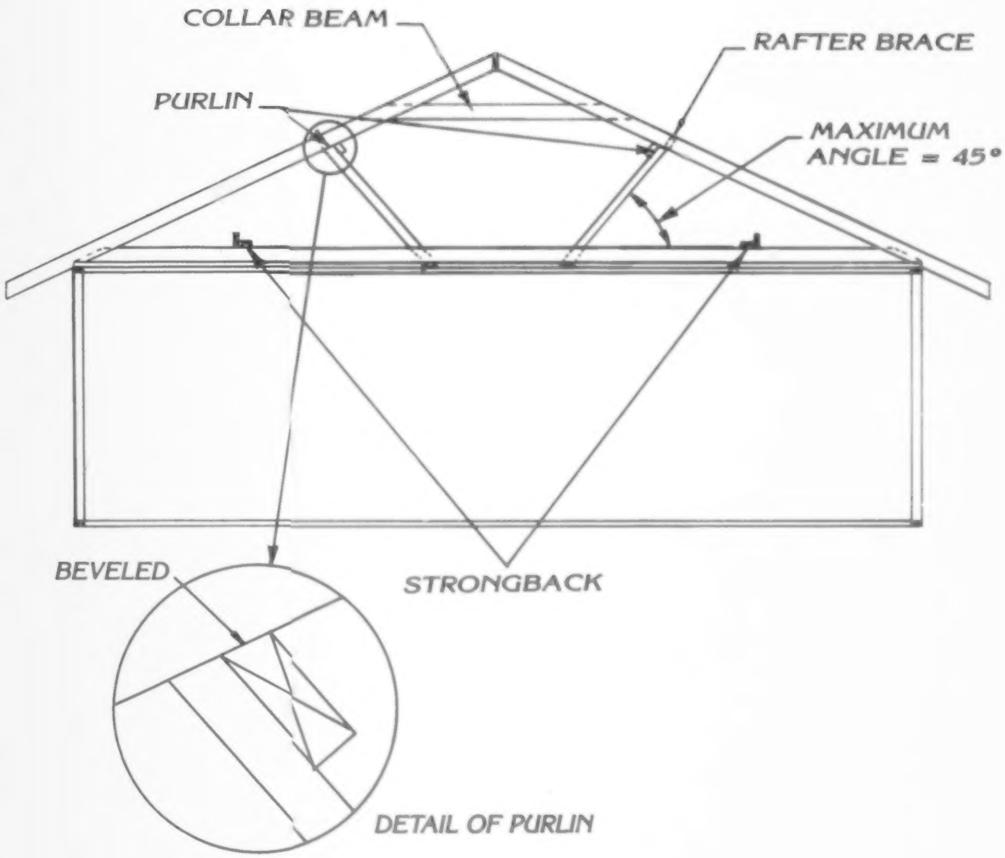
3) Stretch a string from the top of the hip to the bottom to aid in keeping the hip line straight

f. Erect remaining rafters

C. Install purlins, strongbacks, and collar beams as required (See Figure 38)

JOB SHEET #2

FIGURE 38


COLLAR BEAM
RAFTER BRACE
PURLIN
MAXIMUM ANGLE = 45°
BEVELED
STRONGBACK
DETAIL OF PURLIN

(NOTE: Purlins will need to be beveled to match pitch of the roof.)

D. Trim rafter tails

1. Mark length of each end rafter at determined length
2. Chalk a line on top of all rafters to locate cutting line

   (NOTE: It may be necesary to adjust procedures for crooked rafter tails.)

JOB SHEET #2

3. Mark side of each rafter with framing square for a square end cut

4. Cut off tails with power handsaw

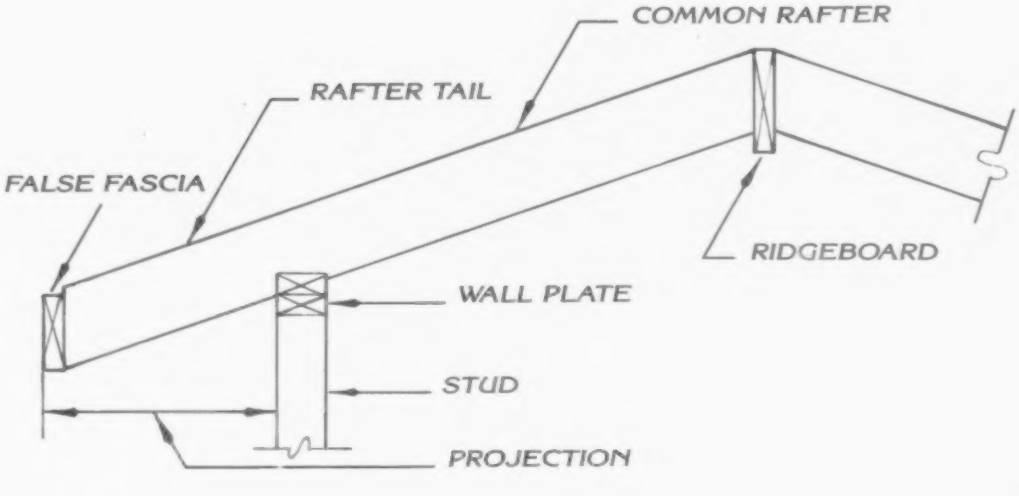
CAUTION

Erect a platform to use while cutting, and assume a comfortable and safe position before starting each cut.

E. Nail false fascia to ends of all rafters around structure's perimeter, allowing ends on gable roof to extend far enough for barge rafter (Figure 39)

(NOTE: When projection exceeds 16 inches, lookouts are needed and are placed every 2 feet. All splices for false fascia must be on rafter ends.)

FIGURE 39

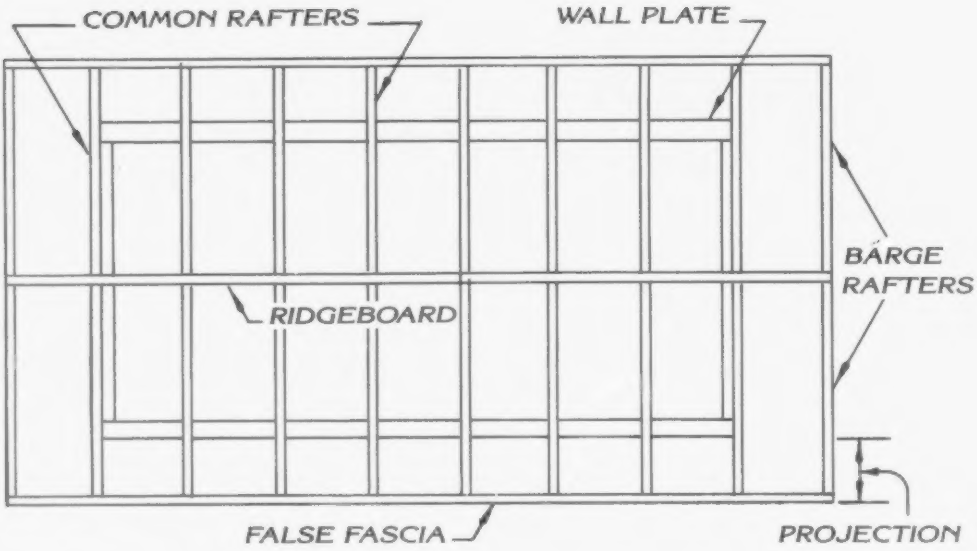

COMMON RAFTER
RAFTER TAIL
FALSE FASCIA
RIDGEBOARD
WALL PLATE
STUD
PROJECTION

F. Install barge rafters on gable roof (See Figure 40)

(NOTE: Additional lookouts may be needed to support the barge rafters. Barge rafters have no bird's-mouth cut.)

JOB SHEET #2

FIGURE 40


COMMON RAFTERS
WALL PLATE
BARGE RAFTERS
RIDGEBOARD
FALSE FASCIA
PROJECTION

G. Clean up area and put away all tools and materials

ROOF FRAMING
UNIT III

JOB SHEET #3 — FRAME A GABLE END WITH VENT OPENING

I. Tools and materials

A. 100-foot tape

B. Folding rule or steel tape

C. Framing square

D. Claw hammer

E. Handsaw

F. Power handsaw and extension cord

G. Hand level

H. Plumb bob and line

I. Stud material

J. 16d and 8d nails

K. Specifications (furnished by instructor)

II. Procedure

A. Plumb down from center of gable to top of end-wall top plate

B. Square a line across end-wall top plate at determined point

C. Lay out vent opening by measuring from centerline each way one-half the opening size needed for vent

D. Lay out and mark stud locations as specified

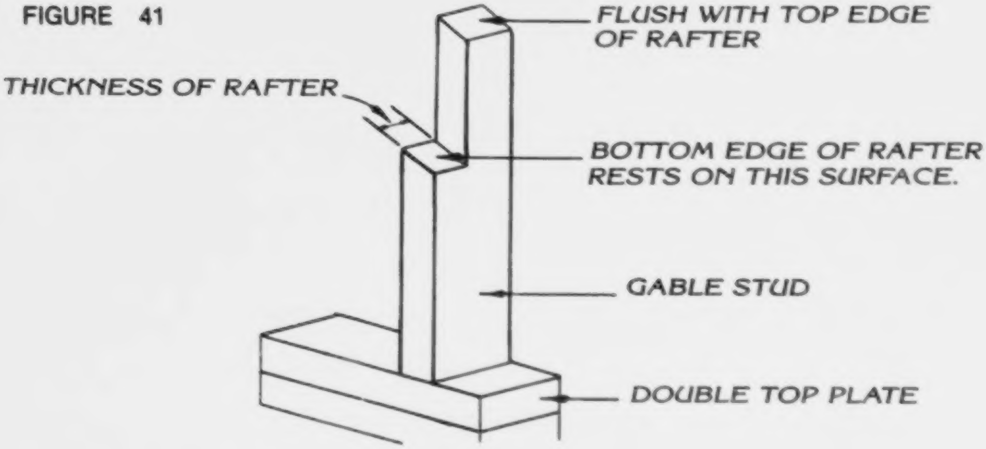
E. Stand a stud upright at first mark and plumb it

F. Mark across edge of stud at underside of rafter (See Figure 41)

(NOTE: This mark will give the correct cutting angle; cut only the depth of the thickness of the rafter.)

JOB SHEET #3

FIGURE 41

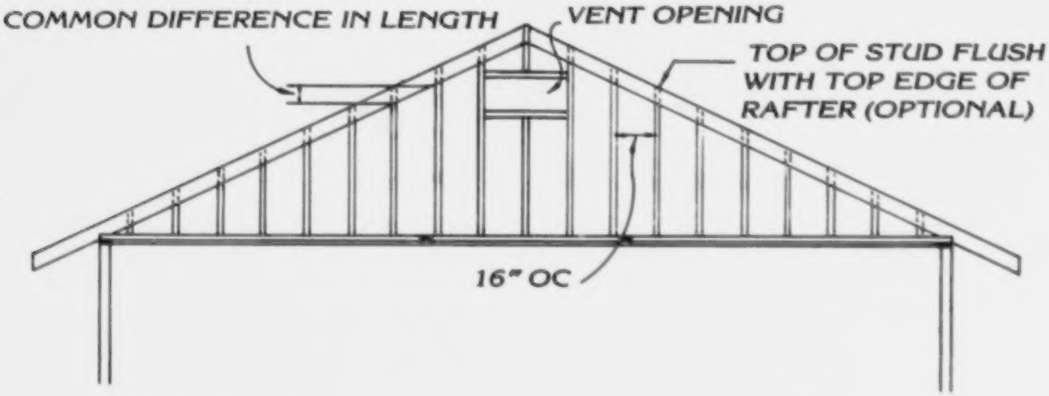

FLUSH WITH TOP EDGE OF RAFTER
THICKNESS OF RAFTER
BOTTOM EDGE OF RAFTER RESTS ON THIS SURFACE.
GABLE STUD
DOUBLE TOP PLATE

G. Repeat steps E and F at remaining stud locations

H. Cut all studs, plumb them in place, and nail in position

(NOTE: When stud spacing is laid out from a centerline as above, cut studs in pairs, as they will fit on each side. Distance in length between the two studs will be the common difference and can be used to cut all the other studs. This is also found on the framing square. See Figure 42.)

FIGURE 42


COMMON DIFFERENCE IN LENGTH
VENT OPENING
TOP OF STUD FLUSH WITH TOP EDGE OF RAFTER (OPTIONAL)
16" OC

I. Nail in header and sill for vent

J. Nail cripple studs in center above and below vent opening

K. Clean up area and put away all tools and materials

ROOF FRAMING
UNIT III

JOB SHEET #4 — CONSTRUCT OPENING FOR A CHIMNEY

I. Tools and materials

- A. 100-foot tape
- B. Folding rule or steel tape
- C. Framing square
- D. Claw hammer
- E. Power handsaw and extension cord
- F. Hand level
- G. Plumb bob and line
- H. Pencil
- I. Joist and header material
- J. 16d and 8d nails
- K. Plans (furnished by instructor)

II. Procedure

- A. Check plans to establish chimney location
- B. Lay out opening on floor

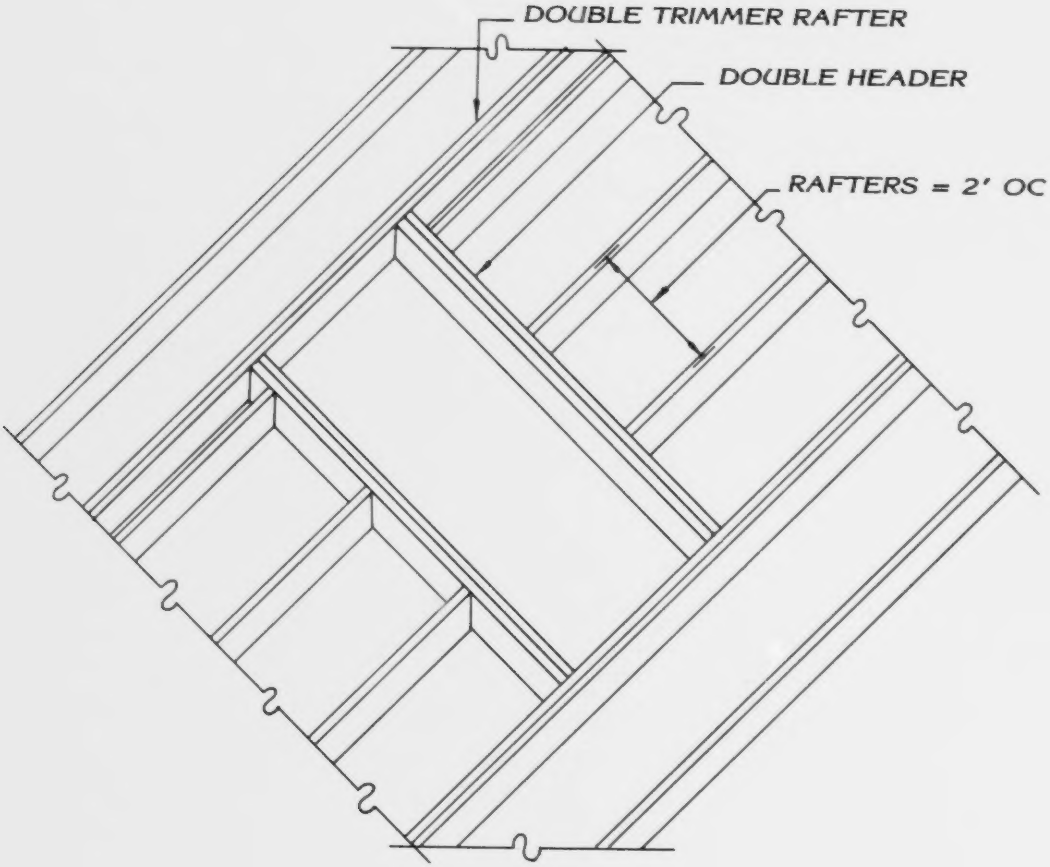
  (NOTE: Provide at least 2-inch clearance on ends and sides.)
- C. Use plumb bob and line to lay out opening on rafters from floor layout
- D. Nail temporary board across top of rafters to be cut

  (NOTE: Board will hold ends of rafters in place until headers are installed.)
- E. Measure and cut headers to size
- F. Cut rafter, allowing for clearance and double headers if required (See Figure 43)

  (NOTE: Double headers should be used on large openings.)
- G. Plumb and nail headers in place
- H. Add trimmer rafter to both sides of opening (See Figure 43)

JOB SHEET #4

FIGURE 43


DOUBLE TRIMMER RAFTER
DOUBLE HEADER
RAFTERS = 2' OC

I. Clean area and put away tools and materials

ROOF FRAMING
UNIT III

JOB SHEET #5 — APPLY ROOF SHEATHING

I. Tools and materials

A. Power handsaw and extension cord

B. Claw hammer

C. Folding rule or steel tape

D. Chalk line

E. Nails as specified for sheathing

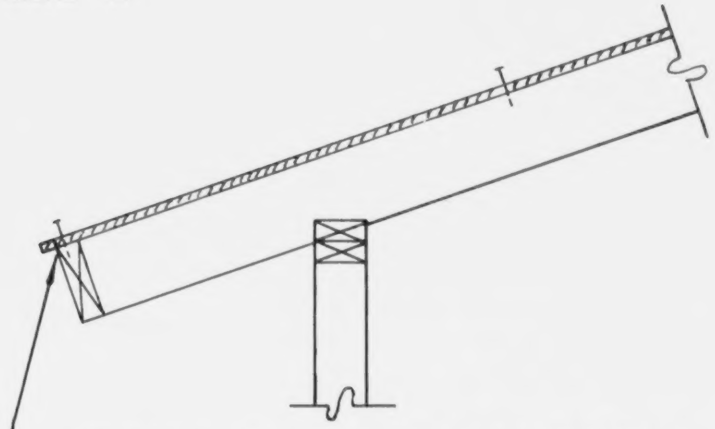
F. Plans and specifications (furnished by instructor)

(NOTE: See specifications for sheathing material used to determine any special installation requirements.)

II. Procedure

A. Start first sheathing board 3/4" past face of false fascia and face of barge rafter (Figure 44)

FIGURE 44



START SHEATHING 3/4" BEYOND FACE OF FASCIA.

B. Allow sheathing to run wild over hip on hip roof; chalk a line and cut with power handsaw after sheathing has been installed

JOB SHEET #5

C. Tack all boards in place; chalk a line on center of each rafter and finish nailing

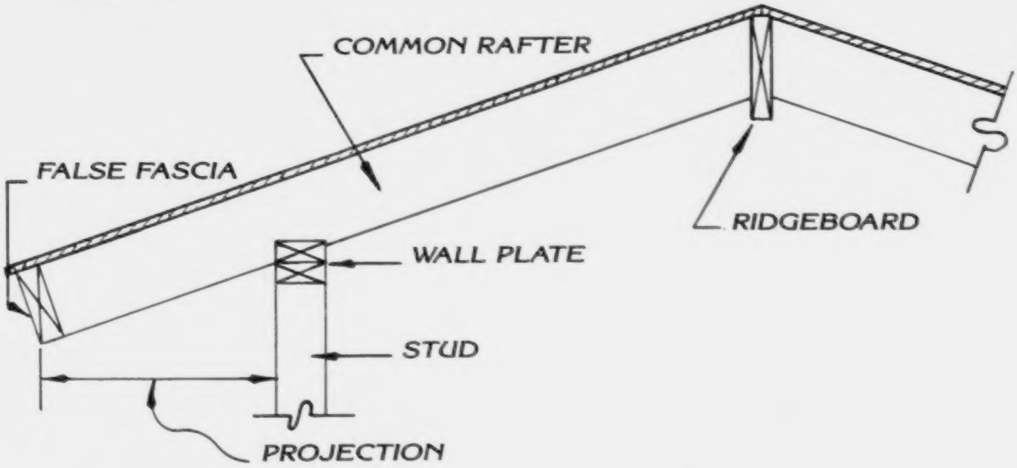
(NOTE: All splices must be made on a rafter with joints staggered no more than four feet.)

D. Finish ridge

1. Cut first side to fit center of ridgeboard

2. Cut opposite side to fit center of ridgeboard (Figure 45)

FIGURE 45


COMMON RAFTER
FALSE FASCIA
RIDGEBOARD
WALL PLATE
STUD
PROJECTION

E. Clean area and put away tools and materials

ROOF FRAMING
UNIT III

TEST

NAME ____ SCORE __________________

1. Match to their correct definitions terms associated with roof framing. Write the correct numbers in the blanks. Definitions continue on the next page.

______a. Structure that projects from a sloping roof and usually includes a window

______b. Angle or degree of slope of roof

______c. Total height of rafter above top plate

______d. Rafter that extends diagonally from top plate to form the intersection of an internal roof angle

______e. Horizontal distance from outside of top plate to centerline of ridgeboard; usually one-half of span

______f. Horizontal distance from outside of one exterior wall to outside of opposite exterior wall

______g. Exposed rafter that is located at end of gable roof

______h. Rafter that extends from double top plate to ridgeboard; roof's main framing member

______i. Rafter that extends from double top plate at corner of structure to ridgeboard, forming the angle for a hip roof

______j. Short rafter that fits between top plate and hip or valley rafter, or between ridgeboard and hip or valley rafter

______k. Inclination of roof's surface expressed as one unit of rise or fall to so many horizontal units, usually "X" inches in twelve

______l. Brace used in framing to strengthen or improve alignment of other framing members

______m. Horizontal distance from building to edge of roof

______n. Small door or opening in the floor or roof of a building

1. Valley rafter
2. Span
3. Jack rafter
4. False fascia
5. Strongback (stiff-back)
6. Rise
7. Barge rafter (verge rafter)
8. Rake
9. Scuttle
10. Projection
11. Overhang
12. Hatch
13. Hip rafter
14. Run
15. Common rafter
16. Pitch
17. Dormer
18. Slope

TEST

_____o. Section of roof that extends from building line to edge of roof

_____p. Trim members that run parallel to roof slope and form finish between roof and wall at gable end

_____q. Small opening in a wall or roof furnished with a lid

_____r. Horizontal material the same thickness and width as roof rafters nailed to rafter tails and covered with finish fascia board.

2. List six types of roof supports.

a. ____________________

b. ____________________

c. ____________________

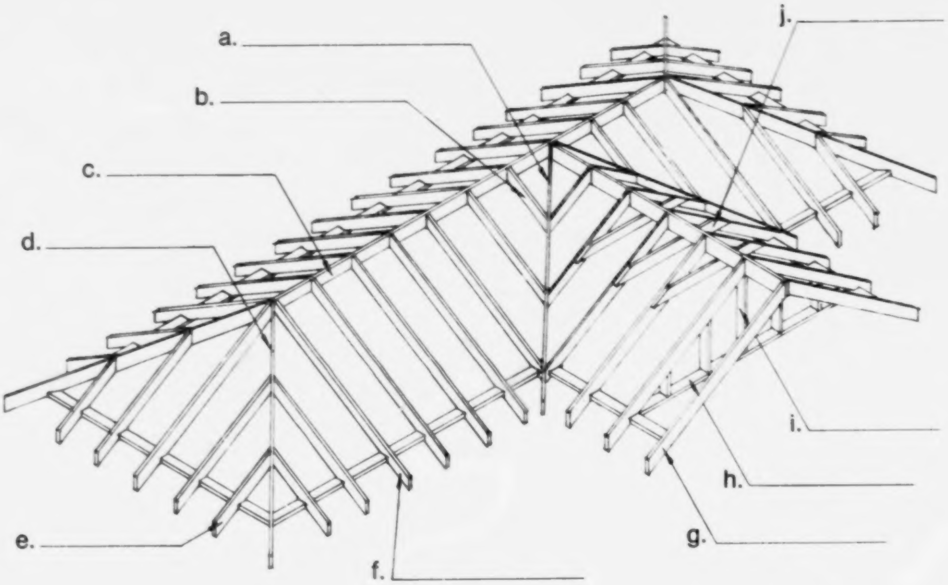
d. ____________________

e. ____________________

f. ____________________

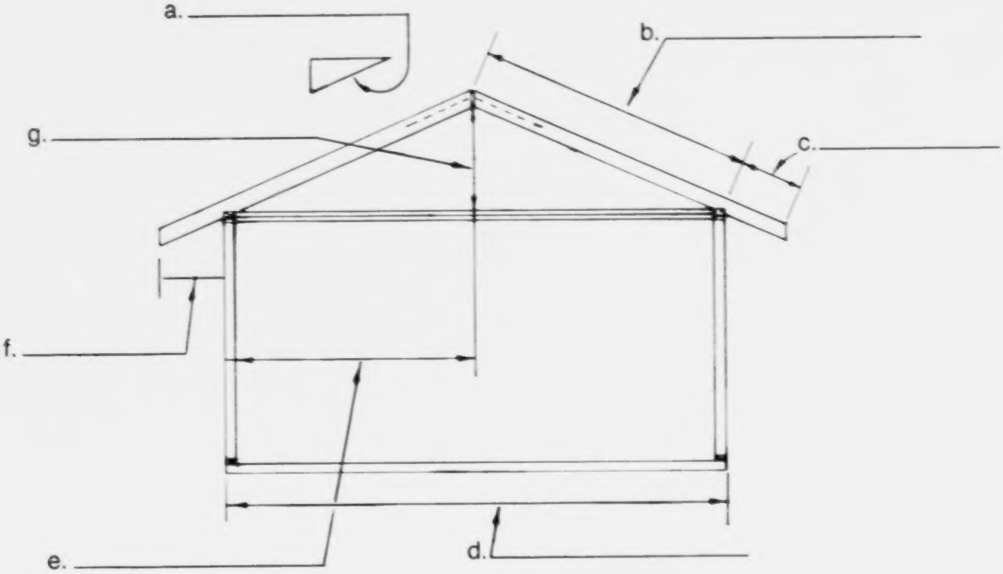
3. Identify the roof framing members in the illustration below. Write the correct names in the blanks.

Rafter tail
Top plate
Valley jack rafter
Hip jack rafter
Valley rafter
Gable stud
Ridgeboard
Hip rafter
Common rafter
Collar beam



TEST

4. Label the roof framing units in the illustration below.



5. Discuss slope and pitch ratios.

   a. Slope — ____

   ____

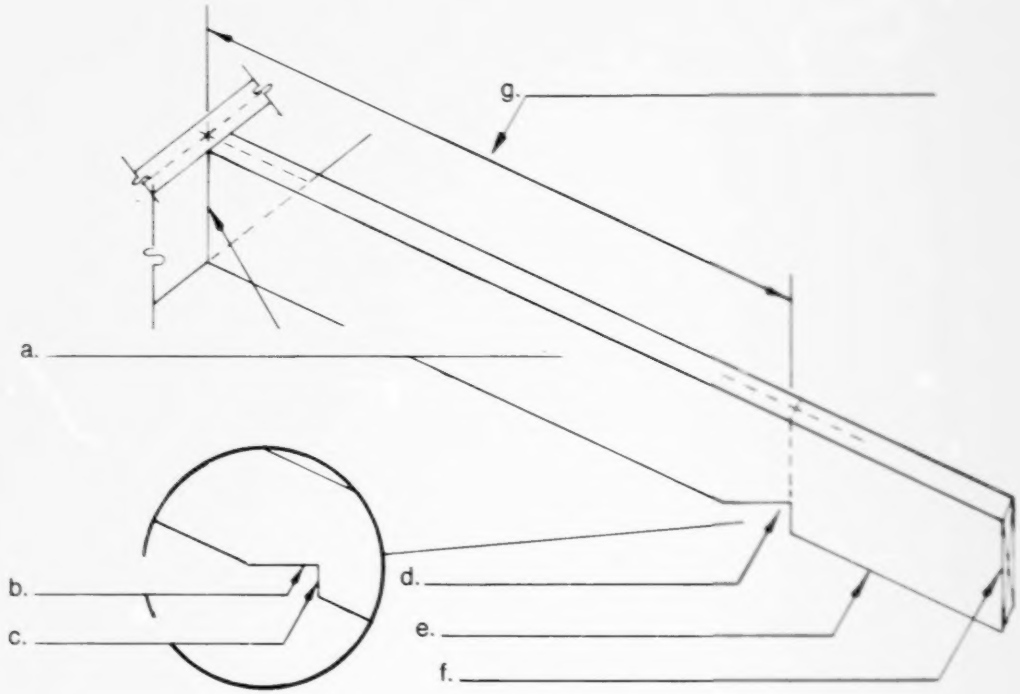
   b. Pitch — ____

   ____

TEST

6. Identify the parts of the rafter illustrated below. Write the correct names in the blanks.

Tail (overhang)	**Line length of rafter**
Tail cut	**Plumb cut**
Plumb cut at ridgeboard	**Bird's-mouth**
Seat cut	



7. List methods for determining rafter length.

a. ________________________________

b. ________________________________

TEST

8. Compute the length of a common rafter for a structure with a span of 26′-0″ and a rise of 8 inches per foot. Use the framing-square table pictured below.

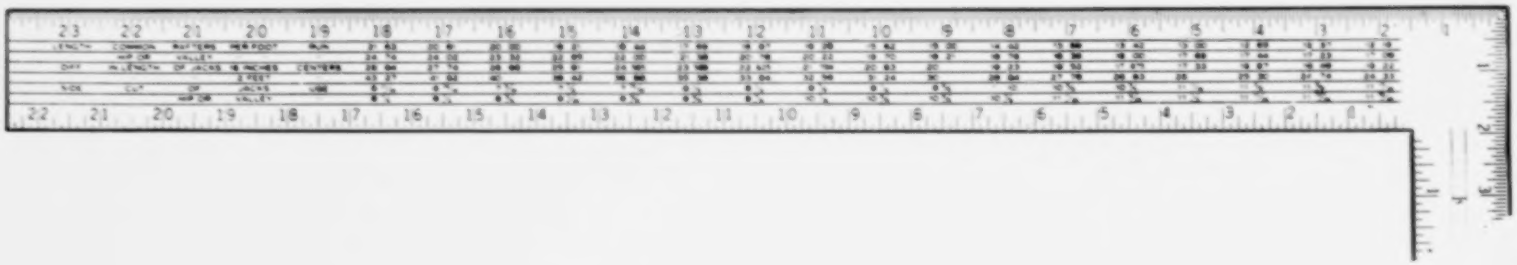
   Rafter length = ____

9. Compute the length of a hip rafter for a building with a run of 14′-0″ and a rise of 6 inches per foot. Use the framing-square table pictured below.

   Rafter length = ____

10. Compute the length of the second jack rafter for a building with a run of 12′-0″, a span of 24′-0″, a rise of 5 inches per foot, and rafters on 2-foot centers. Use the framing-square table pictured below.

    Rafter length = ____


23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

TEST

11. Select from the following list types of roof openings. Write an "X" in the correct blanks.

______a. Saddles

______b. Stair access hatch

______c. Fire and smoke vent

______d. Attic access

______e. Skylights

______f. Stationary louver

______g. Ventilating roof window

______h. Chimney

______i. Fire escapes

______j. Exit doors

______k. Ladder access hatch

______l. Roof vent

______m. Ventilating roof window

______n. Adjustable louver

______o. Firewalls

12. List four types of vents used in roof construction.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

TEST

13. Estimate the number of common rafters needed to frame a gable roof on a structure that is 24′ × 36′ with 24-inch roof projection over the eaves and gable ends. Space rafters 24 inches on center. Write the correct answer in the blank and show your work.

Number of common rafters = ______________________________

(NOTE: Test question 17 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

14. Demonstrate the ability to

    a. Lay out rafter locations on top plate and ridgeboard on 2-foot centers.

    b. Lay out, cut, and erect rafters.

    c. Frame a gable end with vent opening.

    d. Construct opening for a chimney.

    e. Apply roof sheathing.

ROOF FRAMING
UNIT III

ANSWERS TO TEST

1. a. 17
   b. 16
   c. 6
   d. 1
   e. 14
   f. 2
   g. 7
   h. 15
   i. 13
   j. 3
   k. 18
   l. 5
   m. 10
   n. 12
   o. 11
   p. 8
   q. 9
   r. 4

2. a. Wood rafters
   b. Wood trusses
   c. Structural timber
   d. Wood bar joists
   e. Metal trusses
   f. Metal bar joists
   g. Structural steel
   h. Steel purlins
   i. Precast concrete planks
   j. Precast concrete planks
   k. Poured in place concrete beams
   l. Glue laminated arches

3. a. Valley rafter
   b. Valley jack rafter
   c. Ridgeboard
   d. Hip rafter
   e. Hip jack rafter
   f. Common rafter
   g. Rafter tail
   h. Top plate
   i. Gable stud
   j. Collar beam

4. a. Slope
   b. Line length
   c. Overhang
   d. Span
   e. Run
   f. Projection
   g. Rise

5. Discussion should include the following

   a. Slope — Indicates incline of roof as a ratio of vertical rise to horizontal run
   b. Pitch — Indicates incline of roof as a ratio of vertical rise to span

6. a. Plumb cut at ridgeboard
   b. Seat cut
   c. Plumb cut
   d. Bird's-mouth
   e. Tail (overhang)
   f. Tail cut
   g. Line length of rafter

7. a. Framing-square step-off method
   b. Rafter tables

ANSWERS TO TEST

8. 15′-7 1/2″

9. 15′-7 7/8″

10. 13′-0″

11. b, c, e, f, g, h, j, k, l, m, n, o

12. Answer should include any four of the following

    a. Three-inch miniature round vent
    b. Four-inch miniature round vent
    c. Ridge vent
    d. Roof vent
    e. Square attic vent
    f. Triangular attic vent
    g. Soffit vent

13. 42

14. Performance skills evaluated to the satisfaction of the instructor

TRUSSES
UNIT IV

UNIT OBJECTIVE

After completing this unit, the student should be able to identify different types of trusses, parts of trusses and should be able to erect trusses. The student will show this knowledge by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with trusses.
2. Identify types of trusses.
3. Label the main parts of a truss.
4. Identify framing details for trusses.
5. Identify hardware used in truss construction.
6. List advantages of using trusses.
7. State considerations for weight and stress when designing trusses.
8. Identify common types of glue-laminated arches.
9. Demonstrate the ability to
    a. Construct a standard Howe truss.
    b. Erect trusses by hand.
    c. Erect trusses with light crane.
    d. Apply roof sheathing.

TRUSSES
UNIT IV

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Information sheet

   D. Job sheets

      1. Job Sheet #1 — Construct a Standard Howe Truss

      2. Job Sheet #2 — Erect Trusses by Hand

      3. Job Sheet #3 — Erect Trusses with Light Crane

      4. Job Sheet #4 — Apply Roof Sheathing

   E. Test

   F. Answers to test

II. Instructor's guide

   A. Review unit and plan presentation.

   B. Obtain materials necessary to supplement unit.

      1. Transparency masters and competency profiles

         (NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E. Street, N.W. Washington, DC 20006, Phone 202-393-2040.)

      2. Contact manufacturer's and dealers for folders and phamplets on materials and equipment

   C. Introduce unit

      SUGGESTIONS:

      - Tour construction sites where trusses or arches are being erected; point out to the students the planning behind the setting of the particular trusses, safety considerations involved such as hoisting them in place, holding, and bracing (especially the high arches)

SUGGESTED ACTIVITIES

- Have students discuss building and setting trusses, the steps involved in the building process, then the steps and safety precautions involved in setting them, and the need for careful planning

D. Provide students with objective sheet

E. Discuss unit and specific objectives, relating them to your introduction to this unit

F. Provide students with information sheet.

G. Discuss information sheet

1. Use Information Sheet, Section I to discuss terms associated with trusses.

   SUGGESTIONS:

   - Use samples, models, illustrations, plans, and an actual construction site to illustrate and discuss the appropriate parts
   - Provide a knock-down model of a truss, naming each part and its function.

2. Use Information Sheet, Sections II and VIII to discuss types of trusses and arches.

   SUGGESTIONS:

   - Use a model of each type, have students identify each type
   - Discuss each type and the differences in each type
   - Explain the differences and why so many types are available.
   - Point out which ones are more suitable for light construction and which for heavy construction
   - Explain the types of construction the different types of trusses and arches are used in

     Examples

     Churches and cathedrals
     Sports arenas
     Grandstands
     Gymnasiums
     Walkways spanning highways
     Bridges
     Enclosed swimming pool areas
     Shopping centers

SUGGESTED ACTIVITIES

- Have students name other types of constructions using trusses or arches.
- Take students on a field trip to see how many buildings in your area are using trusses and arches and how many different types are used
- If at all possible take students to a manufacturing plant where glue laminated arches are constructed.

3. Use Information Sheet, Sections III and V and Job Sheet #1 to discuss parts of a truss, hardware used on trusses, and the procedures and details used to construct trusses

SUGGESTIONS:

- Discuss parts of a truss and hardware used in the construction of trusses
- Explain to the students that most trusses are fabricated in manufacturing plants and are designed by structural engineers to support prescribed loads and fabricated to exact specifications
- Explain that trusses may be ordered and built to meet special requirements but they must meet tested designs and specifications
- Explain that when ordering trusses they should be ordered from a plant close to the job site to eliminate transportation cost and facilitate delivery
- Also explain that tested designs for trusses are available from American Plywood Association and several other sources
- Invite a person from a fabrication plant to come in and explain how trusses are built and the importance of proper and tight joints; also explain that weight and stress are involved; emphasize how important it is for the cuts and joints to be made properly and fitted tightly together.
- Construct a knockdown model of a truss; have each of the students identify each part of the truss; knockdown the model and have each student reconstruct it.
- Explain where, how, and why each piece of hardware is used.
- Have samples of hardware available for students to become acquainted with.
- Discuss layout of trusses. Use Job Sheet #1 to explain the layout, procedures, and construction of a truss.

SUGGESTED ACTIVITIES

- Have students practice the job sheet procedures.
- Involve all the students in the job sheet procedures, including layout and construction of a truss, then give each student a different type of truss and have them lay it out and construct a model of that particular truss to scale.

4. Use Information Sheet, Sections IV and VI to discuss truss framing details and advantages of using trusses

SUGGESTIONS:

- Discuss the different details illustrated in the information sheet.
- Discuss advantages of using trusses.
- Relate the framing details to other types of framing that the students are familiar with.
- After studying these details ask if they may be able to show other types of details assemblies that may be used.
- Explain why the different details are used and how using some of them could change the complete building layout and sequence of construction, such as how partition walls can all be done after the trusses and roof sheathing is installed, explain how much less time is involved to close in a building as compared to other framing methods and how once the trusses are installed the ceiling joists (bottom board) are also installed.
- Have students practice constructing various types of framing details.

5. Use Information Sheet, Section VII to discuss consideration of weight and stress in the designing of trusses

SUGGESTIONS:

- Invite a structural engineer to visit with your class and explain weight and stress and why it must be considered when designing trusses.
- Have the engineer use your model truss to point out the stress points on the truss and how the weight and stress are distributed to the bearing walls.
- Also have the engineer show what part the tension webs and what part the compression webs play in the construction of the truss.
- Have the engineer explain camber and why it is necessary and how it is constructed into the truss.

G. Provide students with job sheets

SUGGESTED ACTIVITIES

H. Discuss and demonstrate job sheet procedures and allow students to practice

SUGGESTIONS:

- Have students plan the procedures and visualize the construction or erection processes
- Tour construction sites and allow students to watch different methods used to erect trusses and watch carpenters applying sheathing
- Have students complete procedures for each job sheet

I. Review unit

J. Give test

K. Critique test and discuss in class

L. Reteach and retest as necessary

M. Complete appropriate sections of competency profiles

III. Unit references

A. Hendrix, Laborn J. "Bud". *Residential Carpentry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1985.

B. Koel, Leonard. *Carpentry.* American Technical Publishers, Inc., 1985

C. Ramsey, Charles G. and Harold R. Sleeper. *Architectural Graphic Standards.* 7th ed. Edited by Robert T. Packard, New York: John Wiley and Sons, Inc., 1981.

TRUSSES
UNIT IV

INFORMATION SHEET

I. Terms and definitions associated with trusses

A. Truss — Combination of framing members that is usually constructed in a triangular unit and used as a rigid framework to support loads over long spans

(NOTE: Trusses come in a number of designs other than the strictly triangular design. Trusses are also available for use in flooring, headers, or any other support.)

B. Top chord — Upper truss member

C. Bottom chord — Lower truss member

D. Tension web — Truss member connecting top and bottom chords in tension

E. Compression web — Truss member connecting top and bottom chords in compression

F. Glued-laminated arch — Structural timber made of thin pieces of lumber that have been glued together under pressure

(NOTE: Sometimes the lumber is sprung up to desired shape before being glued.)

G. Gang-nail plate — Steel plate with a number of uniform nails that have been stamped out to protrude at right angles from the plate itself; used to strengthen wood-to-wood connections

H. Split ring — Steel ring with a tongue-and-grooved split in the band; used to strengthen wood-to-wood connections

I. Toothed ring — Corrugated and toothed thin steel ring; used to strengthen wood-to-wood connections

J. Camber — Slight arch built into truss to prevent the member from eventually bending from its own weight in addition to the load it carries

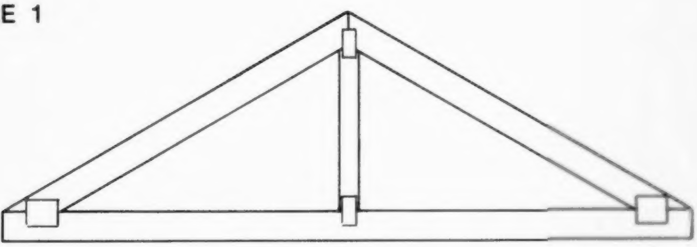
II. Types of trusses (Figures 1 to 23)

(NOTE: Trusses can be built to fit most situations. The trusses illustrated on the following pages are some of the most common types. Trusses may be constructed of solid wood members, steel, glue-laminated timbers, or combinations of wood and steel. Some trusses are built with open webs, and some are built with solid frames and no webs.)

INFORMATION SHEET

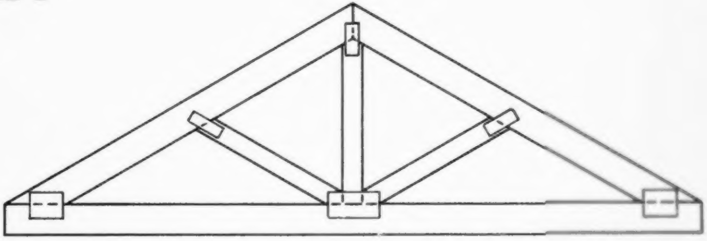
A. King post

FIGURE 1



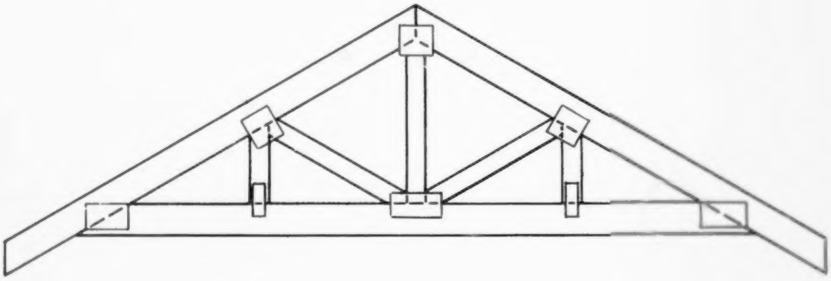
B. Queen post

FIGURE 2



C. Standard Howe truss

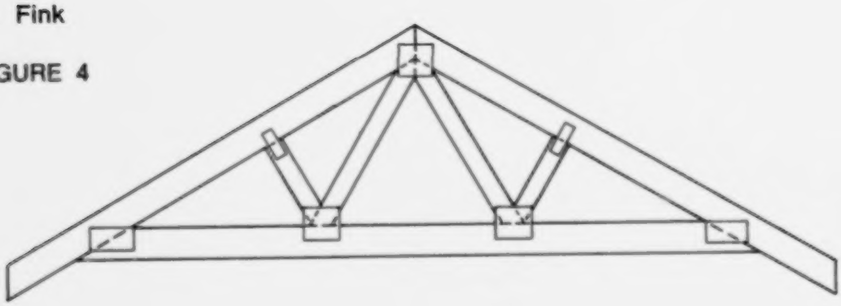
FIGURE 3



INFORMATION SHEET

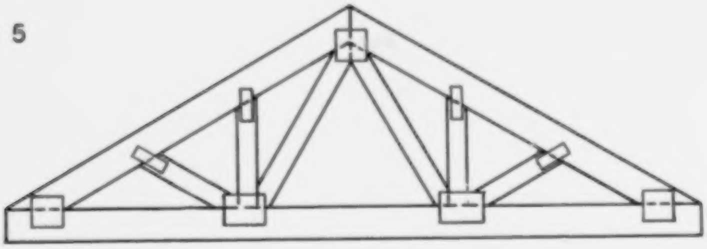
D. Fink

FIGURE 4



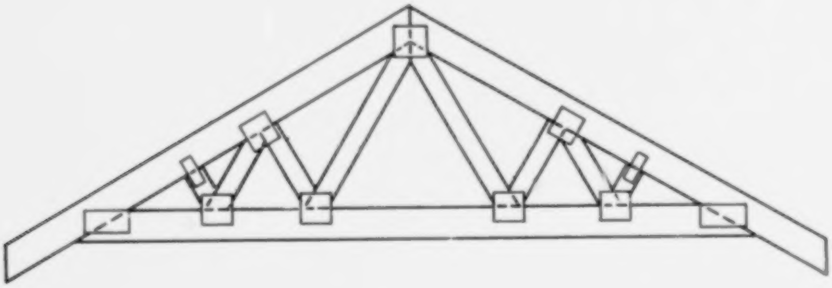
E. Fan

FIGURE 5



F. Double-W (WW) or Belgian

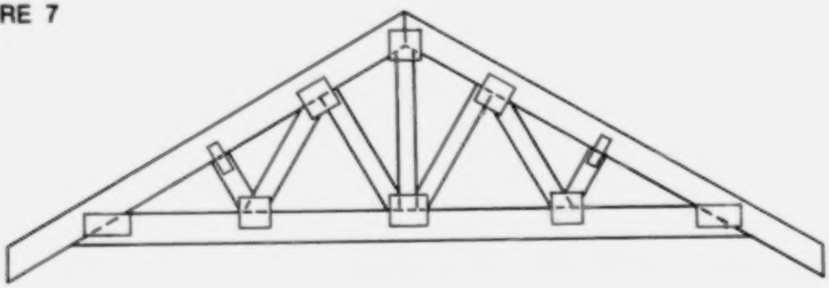
FIGURE 6



INFORMATION SHEET

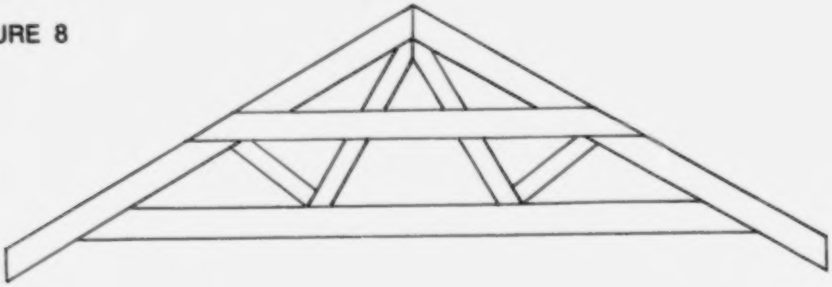
G. Modified queen-post (multiple panel)

FIGURE 7



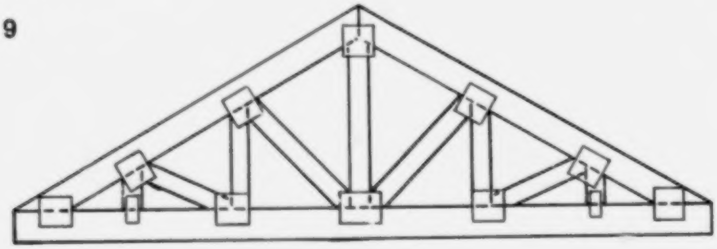
H. Hip-louver

FIGURE 8



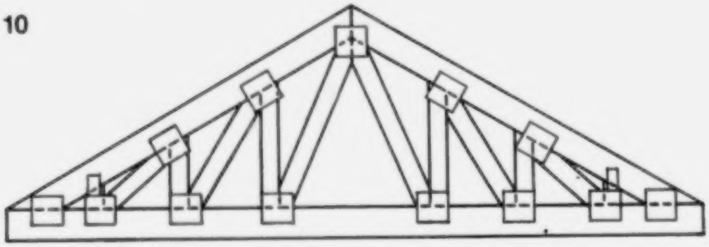
I. Double Howe

FIGURE 9



J. Pratt

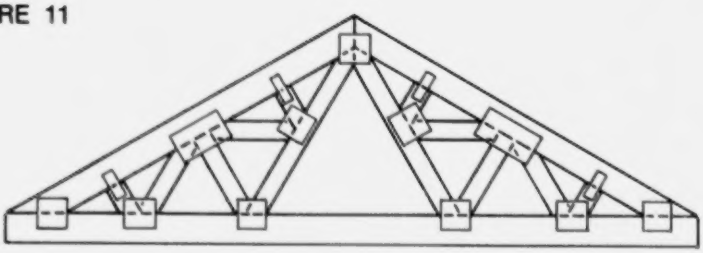
FIGURE 10



INFORMATION SHEET

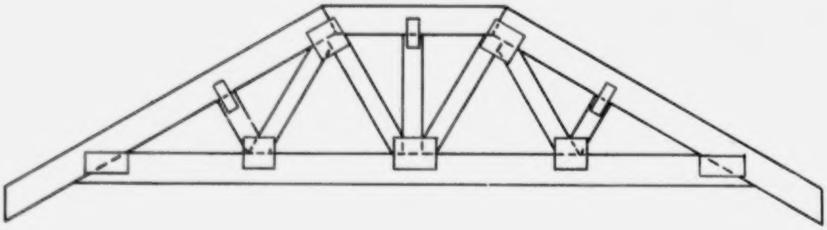
K. Double fink

FIGURE 11



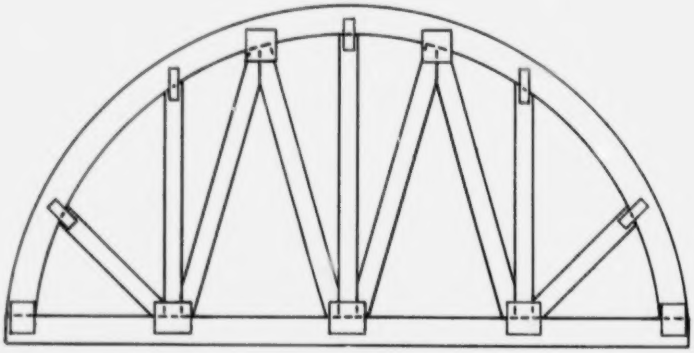
L. Hip

FIGURE 12



M. Bowstring

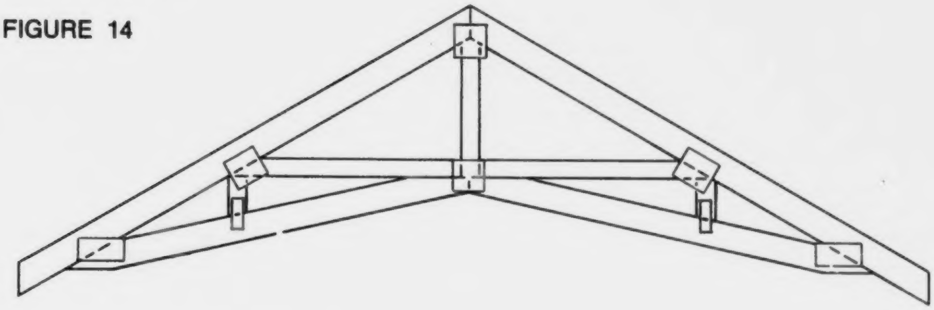
FIGURE 13



INFORMATION SHEET

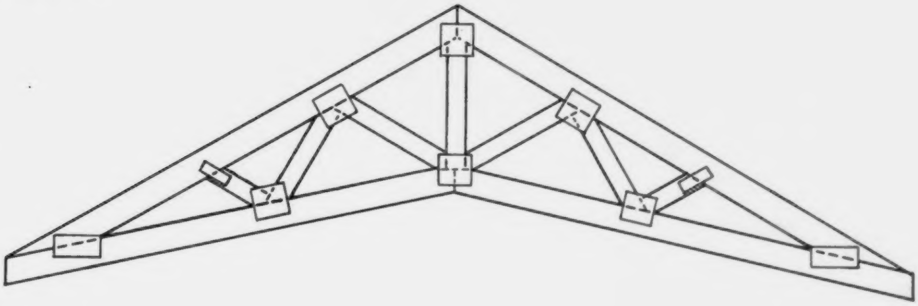
N. Howe scissor

FIGURE 14



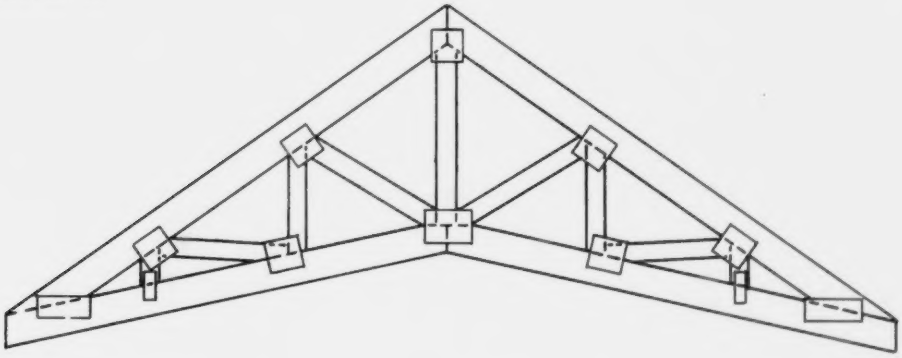
O. Multiple panel scissor

FIGURE 15



P. Double howe scissor

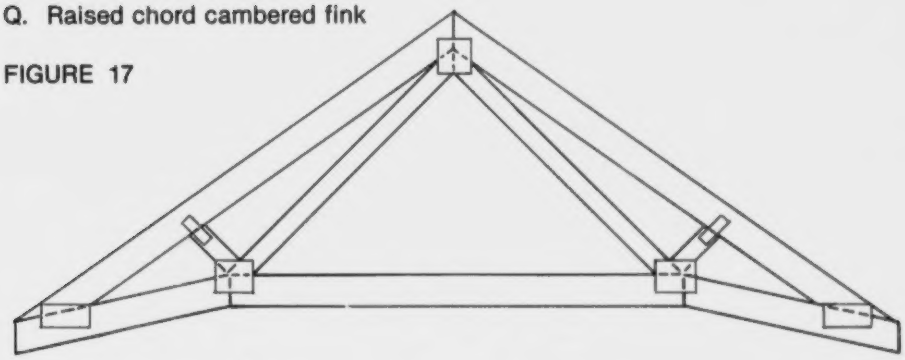
FIGURE 16



INFORMATION SHEET

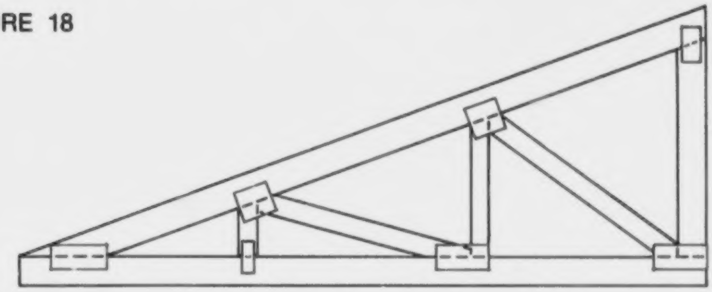
Q. Raised chord cambered fink

FIGURE 17



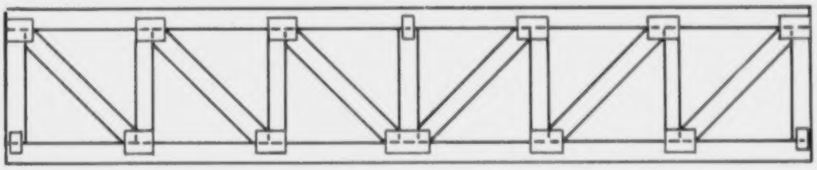
R. Monopitch or sawtooth

FIGURE 18



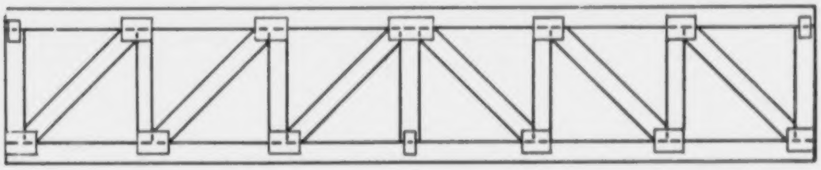
S. Flat pratt

FIGURE 19



T. Flat Howe

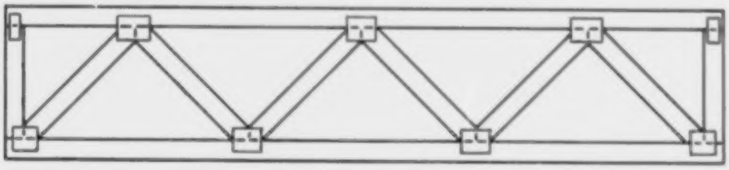
FIGURE 20



INFORMATION SHEET

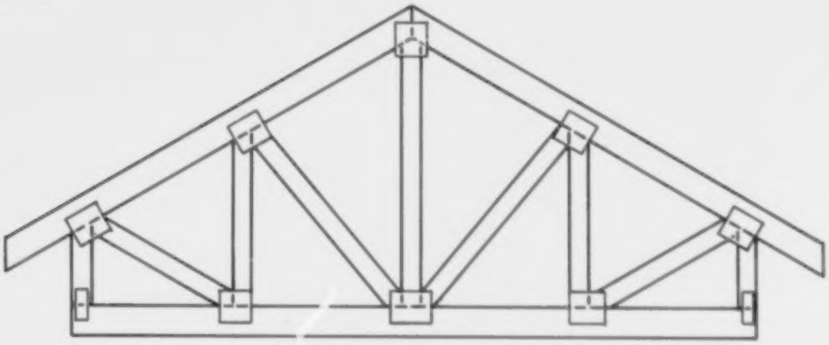
U. Flat warren

FIGURE 21



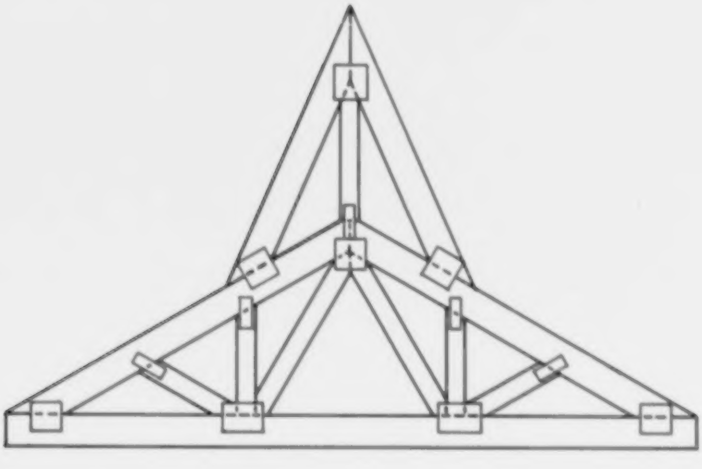
V. Modified

FIGURE 22



W. Piggyback

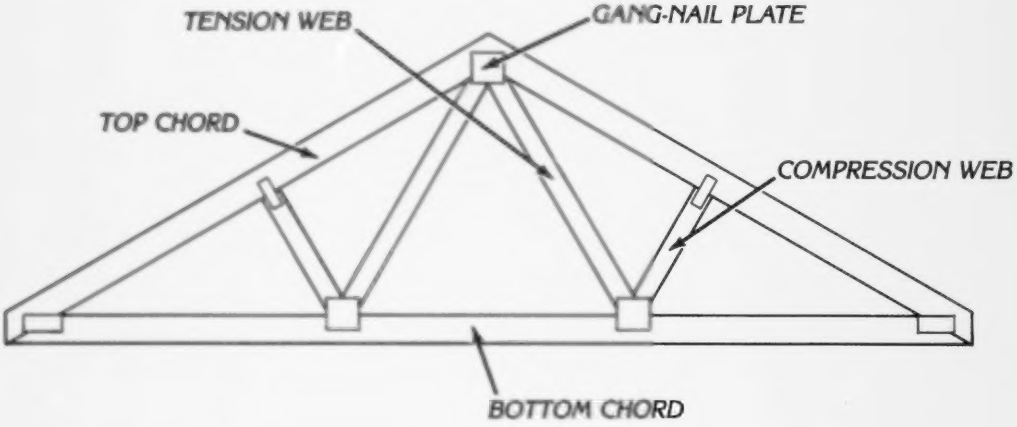
FIGURE 23



INFORMATION SHEET

III. Main parts of a truss (Figure 24)

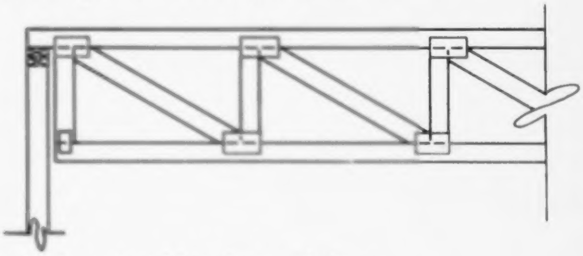
FIGURE 24


TENSION WEB
GANG-NAIL PLATE
TOP CHORD
COMPRESSION WEB
BOTTOM CHORD

IV. Framing details for trusses

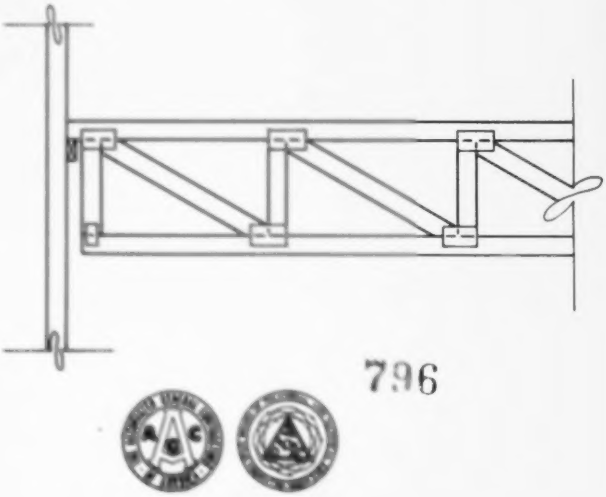
A. Flat truss with top chord bearing on exterior wall

FIGURE 25



B. Flat truss with top chord bearing on ledger

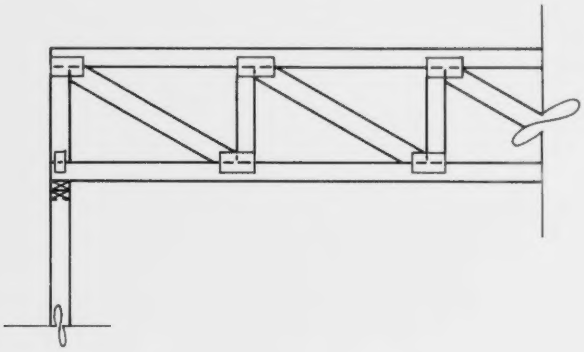
FIGURE 26



INFORMATION SHEET

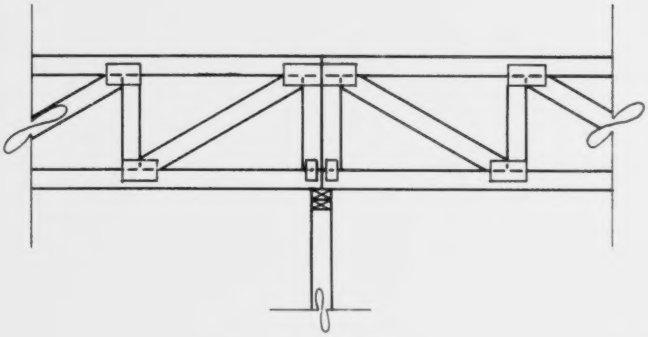
C. Flat truss with bottom chord bearing on exterior wall

FIGURE 27



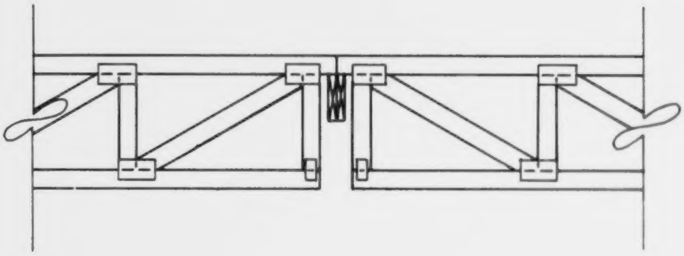
D. Flat truss with interior wall bearing

FIGURE 28



E. Flat truss with interior beam bearing

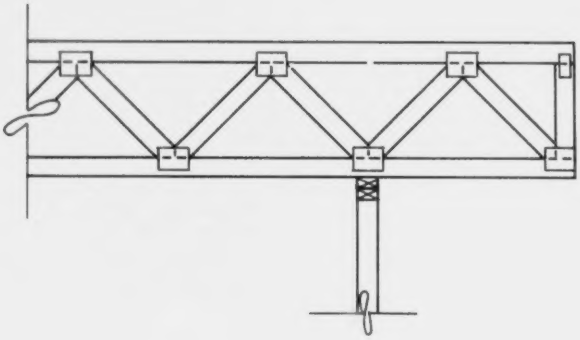
FIGURE 29



INFORMATION SHEET

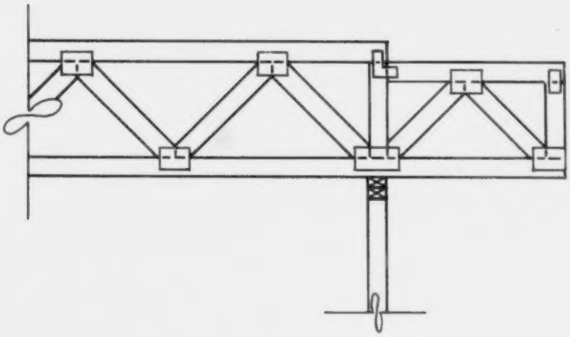
F. Flat truss cantilevered

FIGURE 30



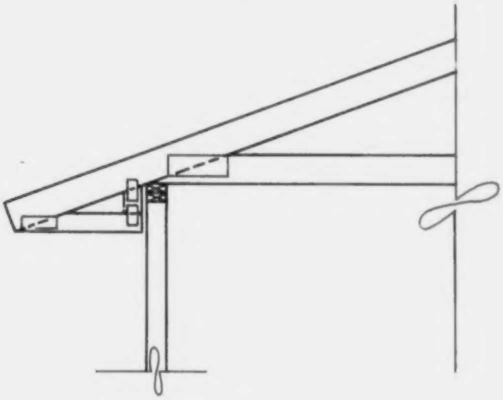
G. Flat truss with cantilever dropped

FIGURE 31



H. Pitched truss overhang with level return

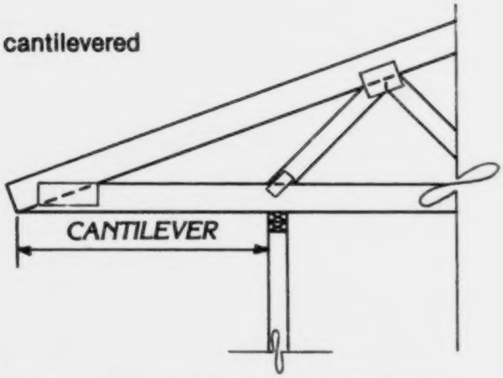
FIGURE 32



INFORMATION SHEET

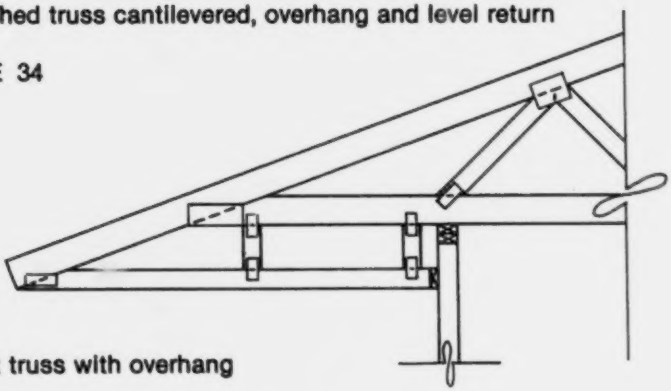
I. Pitched truss cantilevered

FIGURE 33



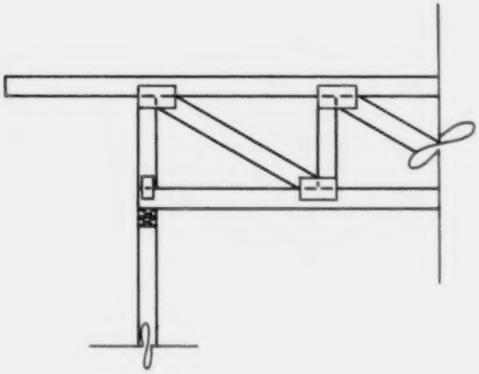
J. Pitched truss cantilevered, overhang and level return

FIGURE 34



K. Flat truss with overhang

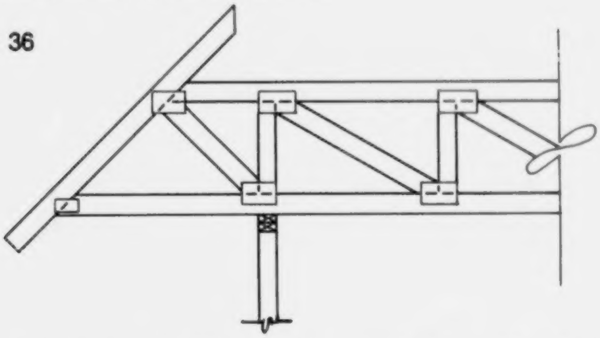
FIGURE 35



INFORMATION SHEET

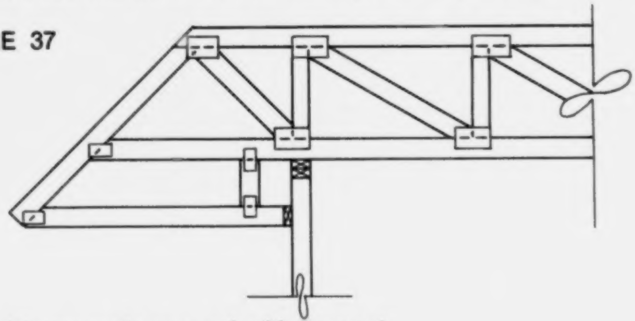
L. Flat truss mansard with cantilever

FIGURE 36



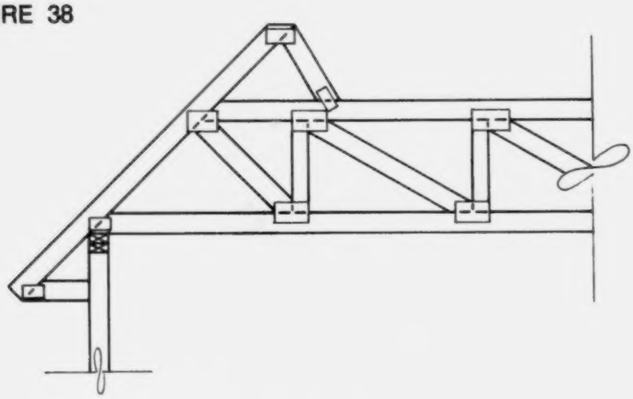
M. Flat truss mansard with cantilever, overhang and level return

FIGURE 37



N. Flat truss and mansard with parapet

FIGURE 38

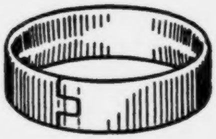


INFORMATION SHEET

V. Hardware used in truss construction (Figures 39 - 46)

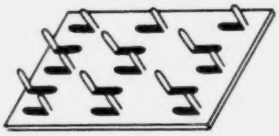
A. Split ring

FIGURE 39



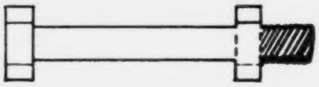
B. Gang-nail plate

FIGURE 40



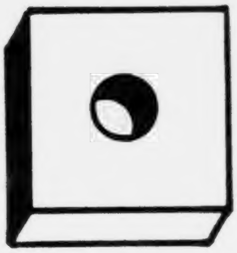
C. Machine bolt

FIGURE 41



D. Plate washer

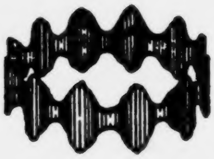
FIGURE 42



INFORMATION SHEET

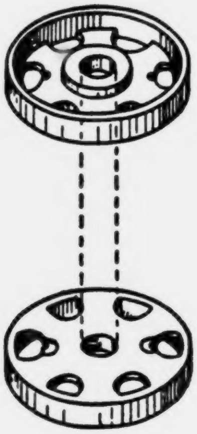
E. Toothed ring

FIGURE 43



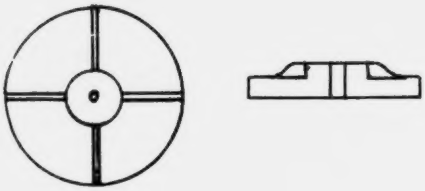
F. Shear plate

FIGURE 44



G. Malleable washer

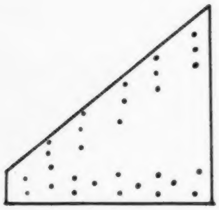
FIGURE 45



INFORMATION SHEET

H. Plywood gussett

FIGURE 46



VI. Advantages of using trusses

A. Span wide spans without support

B. Labor saving

C. Structurally sound

D. Open web type provides fast installation for mechanical trades

E. Reliable performance

F. Esthetic values on laminated finish type

G. Allows more freedom in planning of interior space

VII. Considerations for weight and stress when designing trusses

A. Weight of truss framework material

B. Roof sheathing

C. Roof finish materials

D. Finish ceiling materials

E. Local snow conditions

(NOTE: The flatter the slope, the heavier the snow load; therefore the truss needs to be constructed of heavier material or a different design.)

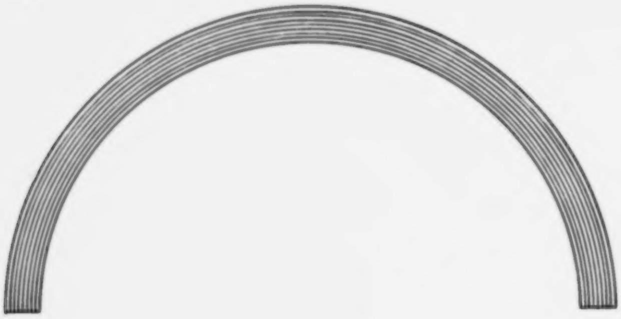
F. Local wind conditions

INFORMATION SHEET

VIII. Common types of glue-laminated arches

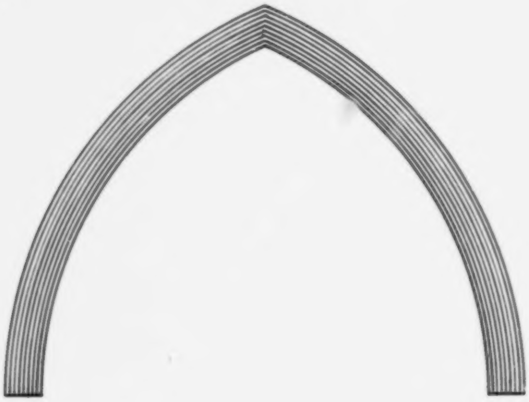
A. Radial

FIGURE 47



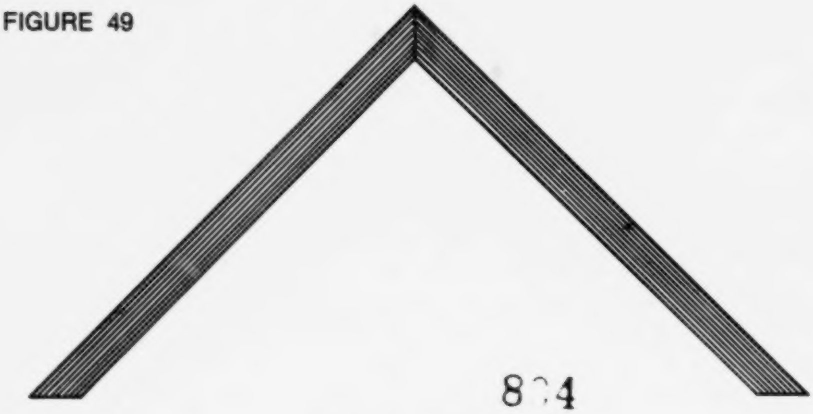
B. Gothic

FIGURE 48



C. A-Frame

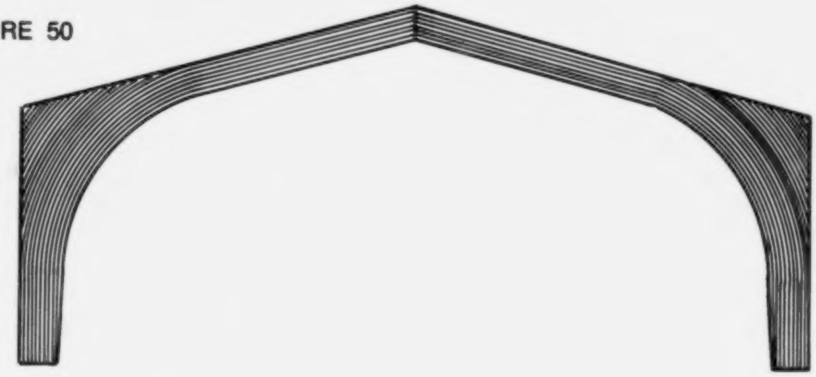
FIGURE 49



INFORMATION SHEET

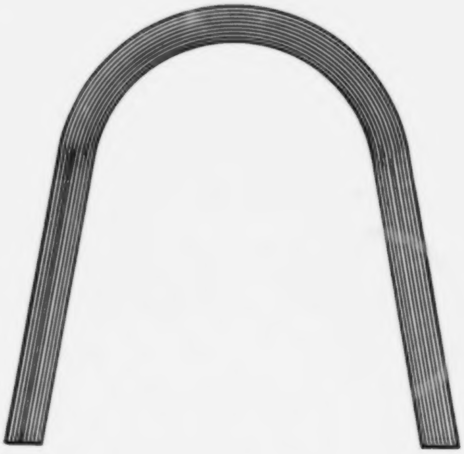
D. Tudor

FIGURE 50



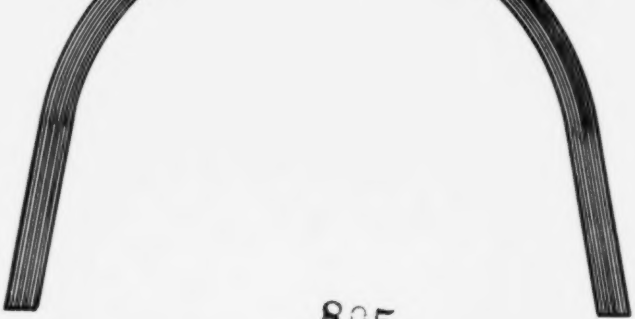
E. Parabolic

FIGURE 51



F. Three-centered

FIGURE 52



TRUSSES
UNIT IV

JOB SHEET #1 — CONSTRUCT A STANDARD HOWE TRUSS

I. Tools and equipment

- A. Assembly table
- B. 100-foot tape
- C. Folding rule or steel tape
- D. Framing square
- E. Try square
- F. Chalk line
- G. Claw hammer
- H. Power handsaw and extension cord
- I. Radial arm saw
- J. Nails
- K. 2×6's for truss members
- L. 2×4's for template
- M. Gang-nail plates or plywood gussets
- N. 2×2 wedges
- O. Plans (furnished by instructor)

II. Procedure

(NOTE: This truss will be a standard Howe truss with a 24 foot span. Unit rise is 5 inches and there will be 12" overhang.)

A. Layout truss on assembly table

1. Snap a chalk line the full length of the table top near bottom
2. Establish a centerline on chalk line; mark point A
3. Measure one half the span (12′) both ways from the center line and mark point B at each end

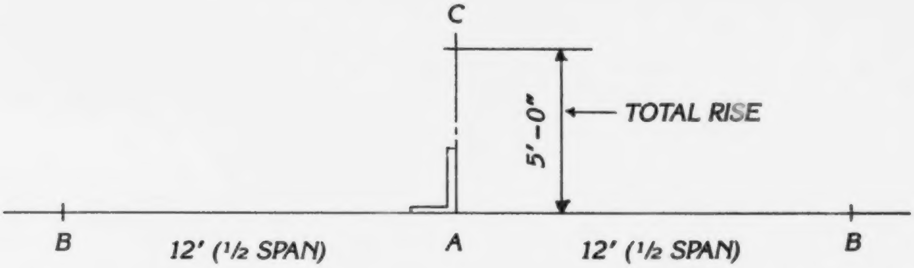
JOB SHEET #1

4. Square a line up from the centerline the total rise (5' – 0") (Figure 53)

   (NOTE: Total rise is total run × unit rise)

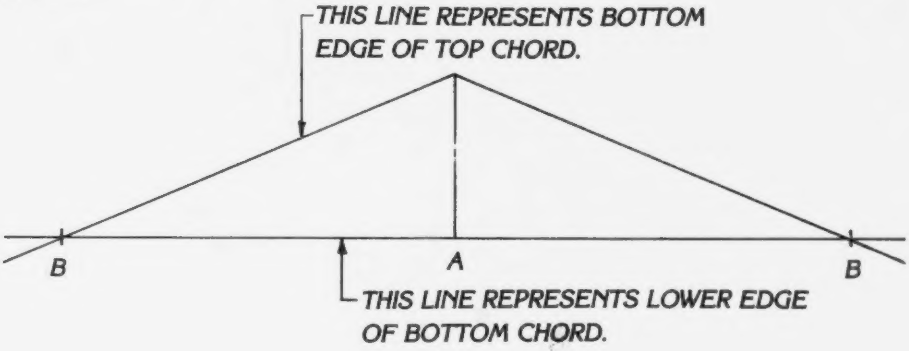
   EXAMPLE: 12
   × 5
   60" or 5'0"

FIGURE 53


C
5'–0"
TOTAL RISE
B
12' (½ SPAN)
A
12' (½ SPAN)
B

5. Snap a line from point "C" to points "B" extending past the "B" points to include the 12" overhang (Figure 54)

FIGURE 54


THIS LINE REPRESENTS BOTTOM EDGE OF TOP CHORD.
B
A
B
THIS LINE REPRESENTS LOWER EDGE OF BOTTOM CHORD.

JOB SHEET #1

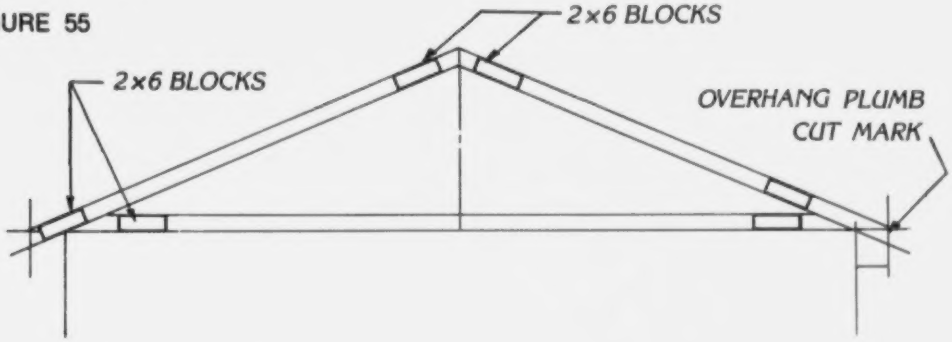
6. Use a short 2×6 block as a guide to mark width of top chords at each end and at each end of bottom chord

   (NOTE: Use a block of the same size material that will be used for the top and bottom chords.)

7. Snap a chalk line between these marks

8. Measure from point "B" out to establish plumb cut "D" for overhang (Figure 55)

FIGURE 55



9. Divide total span into fourths and mark points "E", the centerlines where compression webs are attached to bottom chord

10. Use square to square point "E" up to top chord point "F" on each side

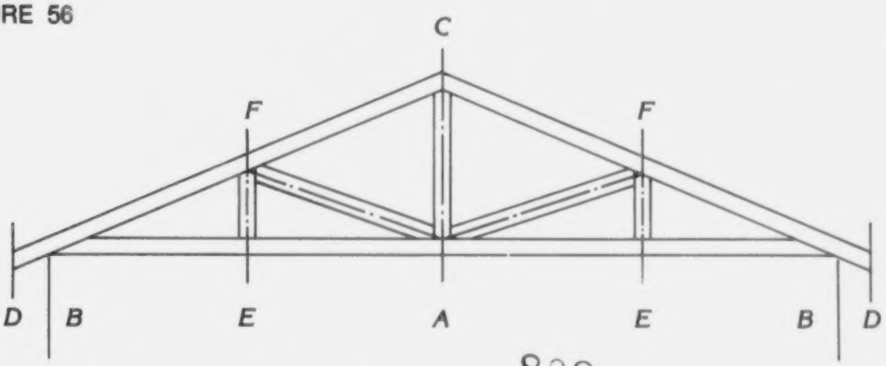
    (NOTE: This establishes location of compression webs.)

11. Use a 2×6 block centered on this line to establish sides of the compression web

12. Snap a chalk line from the bottom point where the two top chords meet to point "E" on top of bottom chord; mark each side to establish location of tension webs

13. Use a 2×6 block centered on this line to establish sides of the tension web (Figure 56)

FIGURE 56



JOB SHEET #1

B. Layout template for constructing trusses

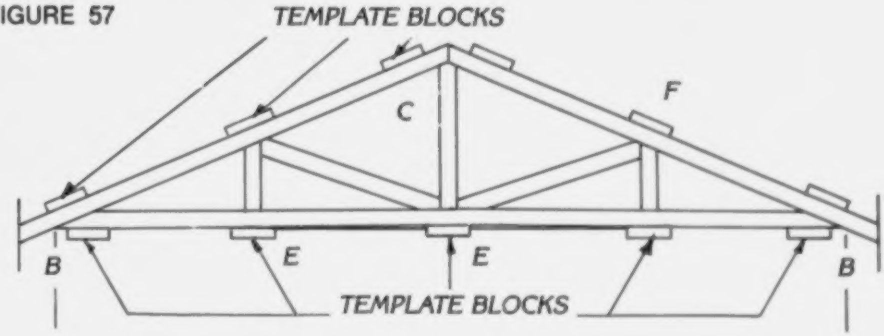
1. Cut several blocks about 12 to 16 inches long for template layout
2. Place a template block on outside of top chord line near peak of truss, then nail to assembly table
3. Do the same at opposite end and in center of top chord
4. Repeat steps 2 and 3 on opposite top chord
5. Place a template block on outside of bottom chord line at each end of bottom chord, then nail to assembly table
6. Place a template block about 1/2 inch above the outside of bottom chord at the center of bottom chord, then nail to assembly table

   (NOTE: Nailing this block above the bottom of chord line will allow for the desired camber of truss.)

7. Snap a chalk line from the center line block to the end block on each end
8. Place a block on this chalkline at the intersection of point "E" on both sides and nail them in place (Figure 57)

   (NOTE: For larger trusses you may want to add blocks for the tension and compression webs.)

FIGURE 57



9. Using this template, cut two each of the bottom chords and the left and right top chords.

   (NOTE: If span of truss is too long the bottom chord will need to be spliced.)

JOB SHEET #1

10. Assemble one set of top and bottom chords using gang nail plates

    (NOTE: The other set will be marked and used for patterns.)

11. Using the template, cut two of each compression and tension web for each side

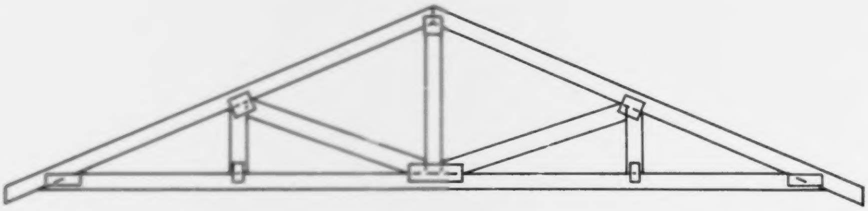
12. Place compression webs in their proper locations and wedge them tightly against adjoining members

13. Place tension webs in their proper locations and wedge them tightly against adjoining members

14. Use gang nail plates on all joints to assemble this side of the truss

15. Turn truss over and use gang nail plates on all joints to complete construction of truss (Figure 58.)

FIGURE 58



TRUSSES
UNIT IV

JOB SHEET #2 — ERECT TRUSSES BY HAND

I. Tools and materials

   A. Folding rule or steel tape

   B. Framing square

   C. Claw hammer

   D. Hand level

   E. String line

   F. Trusses

   G. 2×4 braces

   H. 2×4 stakes

   I. 16d and 8d nails

   J. 1×6's or plywood for catwalk

   K. Plans

II. Procedure

   A. Check plans to determine type of exterior finish

   B. Lay out end truss to allow for exterior finish

   C. Use framing square to layout and mark truss locations 2 feet on center on top plates

   D. Place trusses on ground along one outside wall with one end of trusses leaning against wall

   E. Raise opposite end of one truss and set on opposite outside wall with truss resting upside down

   F. Raise remaining trusses to top of walls following procedure in step E

   G. Starting at one end of structure, set first end truss (See Figure 59)

      1. Use lifting pole to raise top of truss and rotate it to an upright position; use two persons on large trusses

JOB SHEET #2

2. Position truss on layout marks on plates

   (NOTE: Positioning and nailing is done by carpenters on each end of truss.)

3. Toenail truss to plates with 16d nails or use metal truss anchors

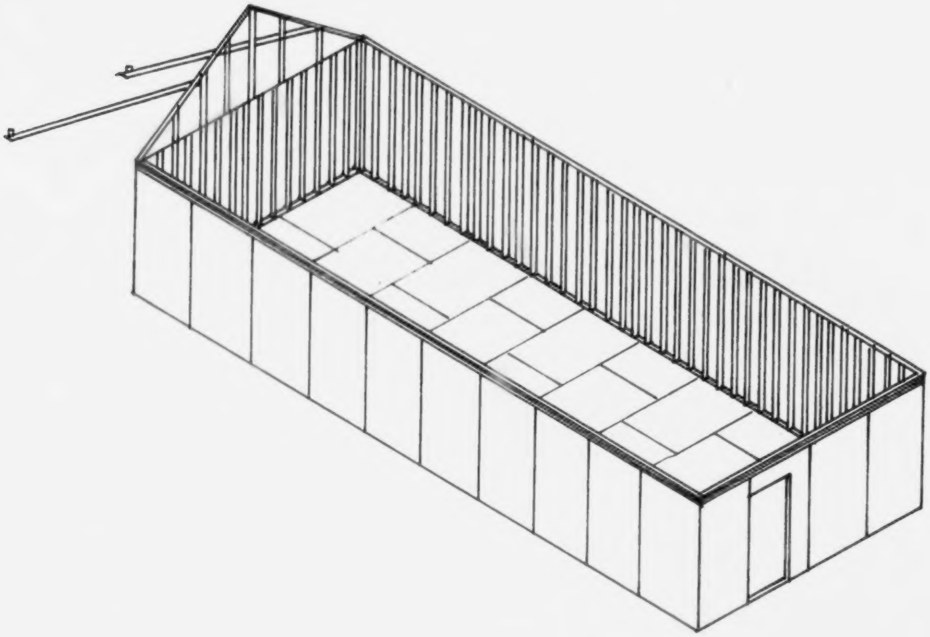
   (NOTE: Sometimes a 2×4 kicker nailed to top plate is used for additional support.)

4. Plumb end truss and nail braces to truss

5. Drive stakes in the ground next to braces near their ends

6. Recheck truss for plumb then nail braces to stakes (Figure 59)

FIGURE 59



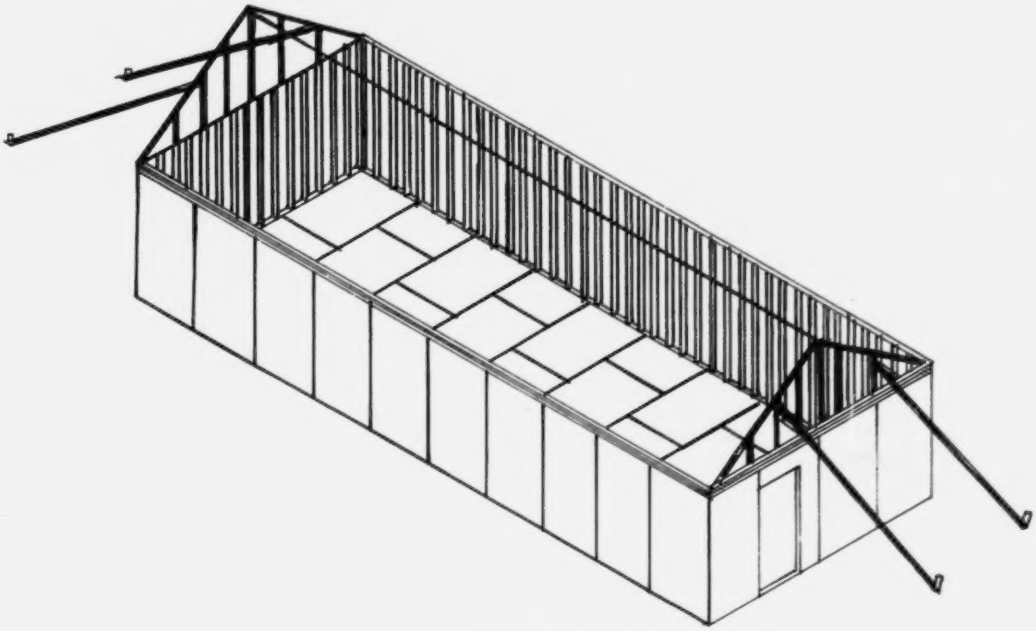
(NOTE: For clarity the trusses that were positioned on the roof in steps E and F are omitted in these figures.)

H. Install an upright at opposite end, or set end truss

JOB SHEET #2

I. Pull line through top of ridge (Figure 60)

FIGURE 60



J. Use line as a guide to keep ridge straight

K. Continue procedures in step G to set trusses until all are set except the last four or five. (See Figure 61)

(NOTE: Every other truss was left off of illustration for clarity.)

JOB SHEET #2

L. Stack remaining four or five trusses away from end of structure and if necessary nail a temporary brace in place to keep trusses from racking (Figure 62)

(NOTE: For clarity some details of the following illustrations have been omitted.)

FIGURE 61

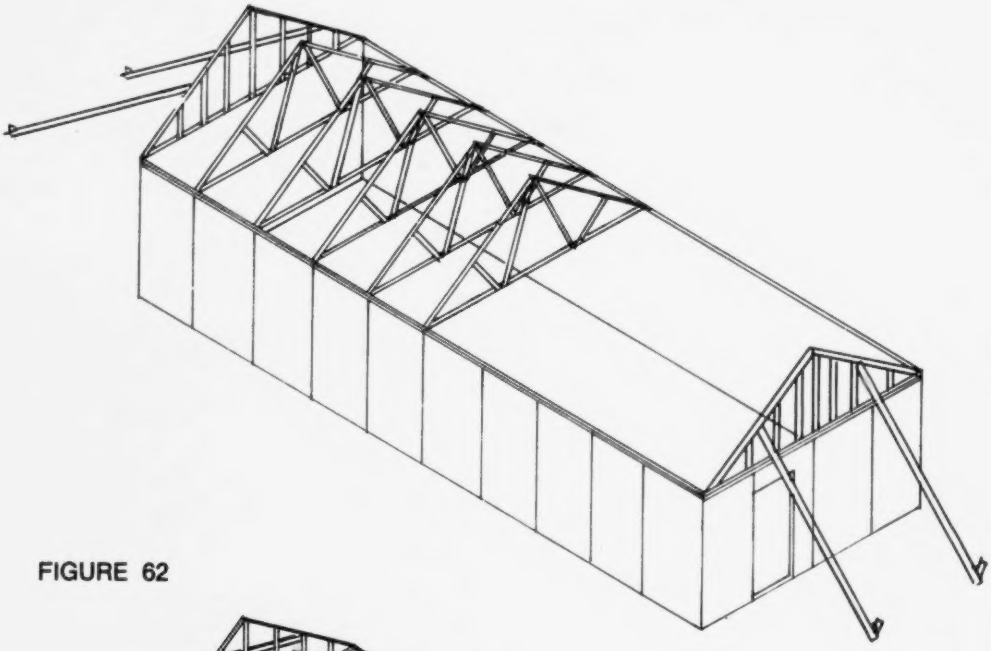
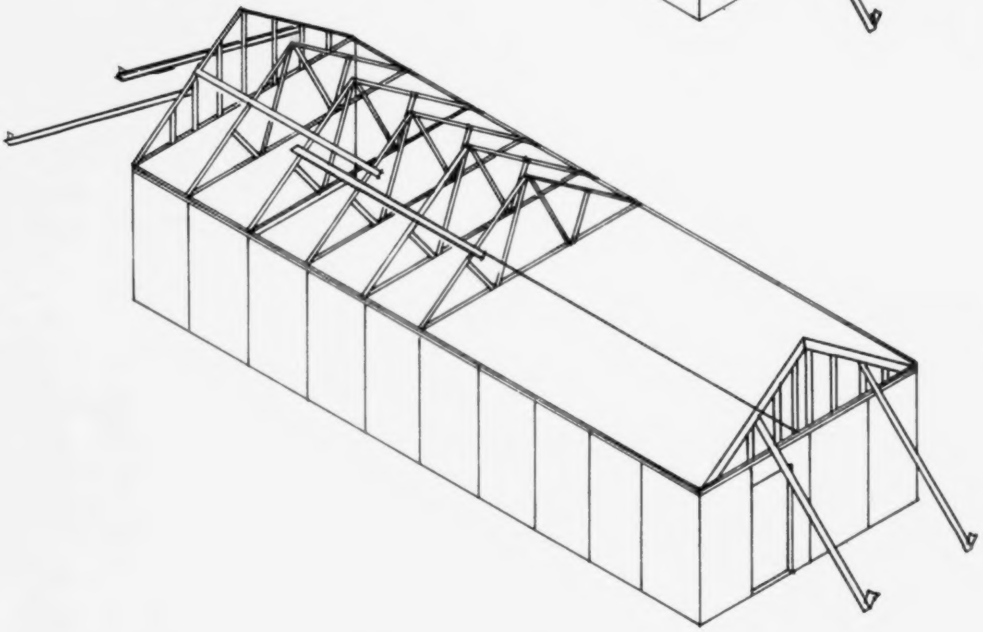


FIGURE 62

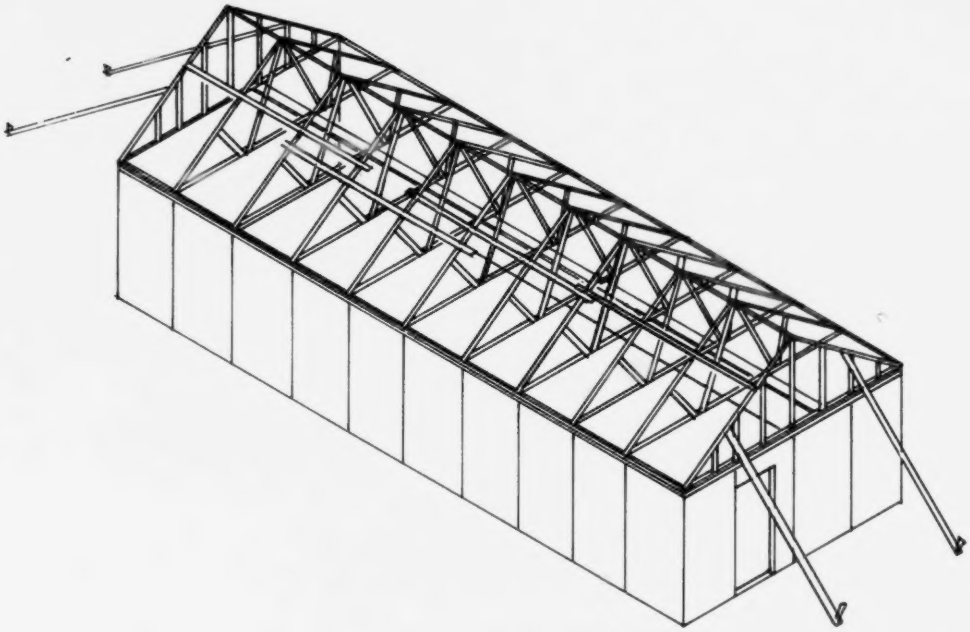


JOB SHEET #2

M. Set, plumb, brace, and nail remaining trusses

N. Recheck trusses at top for 2 feet on center; add braces if necessary (See Figure 63)

FIGURE 63



O. Lay out and nail horizontal bracing on top of bottom chord to hold truss at proper spacing.

P. Install sheathing (See Job Sheet 4)

Q. Remove temporary bracing when you have worked up to the bracing

R. Clean up area and put away tools and materials

TRUSSES
UNIT IV

JOB SHEET #3 — ERECT TRUSSES WITH LIGHT CRANE

(NOTE: It may be necessary to use whatever mechanical equipment is available.)

I. Tools and equipment

   A. Folding rule or steel tape

   B. Framing square

   C. Claw hammer

   D. Hand level

   E. String line

   F. Trusses

   G. 2×4s for braces

   H. 16d and 8d nails

   I. 1×6s or plywood for catwalk

   J. Plans

II. Procedure

   A. Check plans to determine type of exterior finish

   B. Lay out end truss to allow for exterior finish

   C. Use framing square to layout and mark truss locations 2 feet on center on top plate

   D. Use light crane to raise first truss into position

   E. Position truss on layout marks on top plates

   (NOTE: Positioning and nailing is done by carpenters on each end of truss.)

   F. Toenail truss to plates with 16d nails or metal truss anchors

   (NOTE: Sometimes a 2×4 kicker nailed to top plate is used for additional support.)

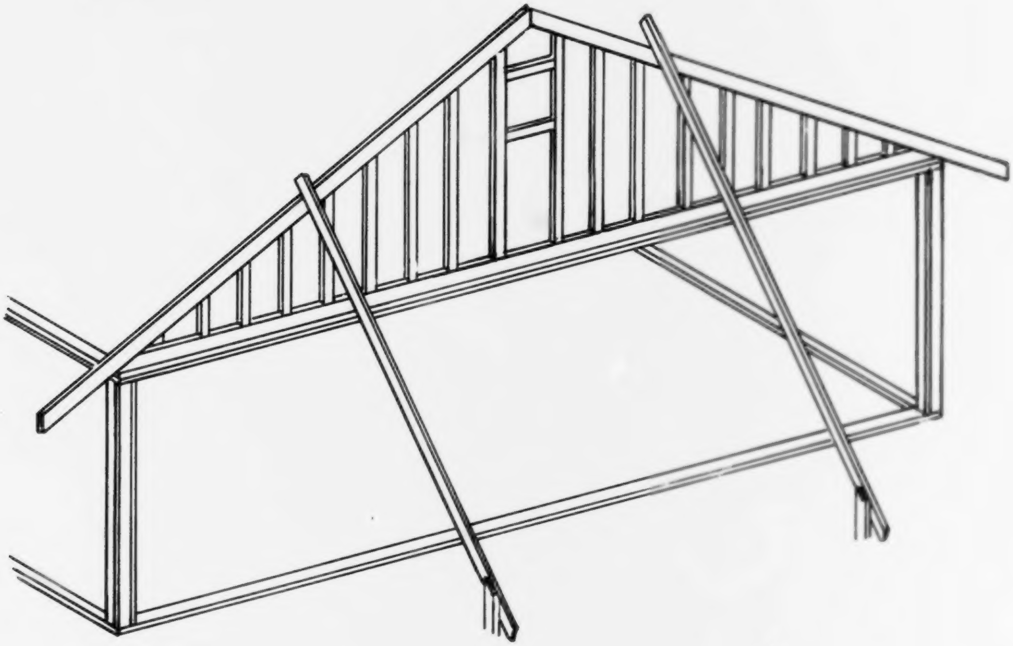
   G. Plumb end truss and nail braces to truss

JOB SHEET #3

H. Drive stakes in the ground next to braces near the ends

I. Recheck plumb and nail braces to stakes (Figure 64)

FIGURE 64



J. Raise, position, and anchor remainder of trusses using procedures in steps D to F

K. Layout lateral braces two feet on centers

L. Fasten lateral braces to each truss after it is nailed in position

(NOTE: Lateral braces may be 1×4s or 2×4s nailed accurately to preceding trusses and should overlap no more than three trusses.)

M. After all trusses are set, permanent lateral braces should be nailed to the bottom chord of trusses, spaced about 10 feet O.C.

N. Apply roof sheathing (See Job Sheet #4)

TRUSSES
UNIT IV

JOB SHEET #4 — APPLY ROOF SHEATHING

I. Tools and materials

A. Power handsaw and extension cord

B. Claw hammer

C. Folding rule or tape

D. Chalk line and real

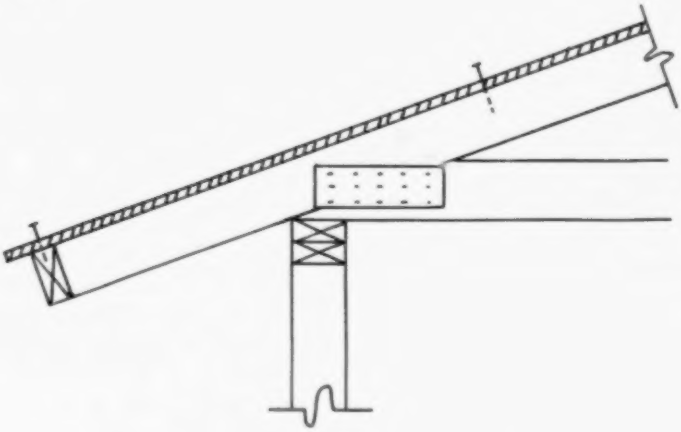
E. Nails (as required in specifications furnished by instructor)

(NOTE: See specifications for sheathing material used to determine special installation requirements.)

II. Procedure

A. Start first board ¾" past face of false fascia and let end run wild over barge rafter (Figure 65)

FIGURE 65



B. Allow sheathing to run wild over hip on hip roof; chalk a line and cut with power handsaw after sheathing has been installed

JOB SHEET #4

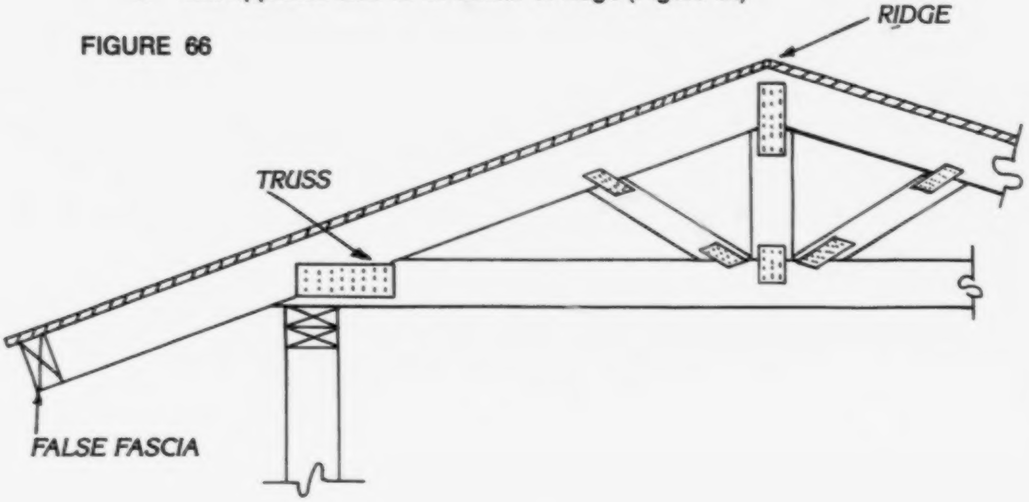
C. Tack all boards in place; chalk a line on center of each rafter and finish nailing

(NOTE: All splices must be made on a rafter with joints staggered.)

D. Finish ridge

1. Cut first side to fit center of ridgeboard
2. Cut opposite side to fit center of ridge (Figure 66)

FIGURE 66



E. Clean area and put away tools and materials

TRUSSES
UNIT IV

TEST

NAME ____ SCORE ________________

1. Write to their correct definitions terms associated with trusses. Write the correct numbers in the blanks.

______a. Truss member connecting top and bottom chords in compression

______b. Structural timber made of thin pieces of lumber that have been glued together under pressure

______c. Corrugated and toothed thin steel ring; used to strengthen wood to wood connections

______d. Upper truss member

______e. Steel plate with a number of uniform nails that have been stamped out to protrude at right angle from the plate itself; used to strengthen wood to wood connection

______f. Truss member connecting top and bottom chords in tension

______g. Combination of framing members that is usually constructed in a triangular unit and used as a rigid framework to support loads over long spans

______h. Lower truss member

______i. Steel ring with a tongue and grooved split in the band; used to strengthen wood to wood connections

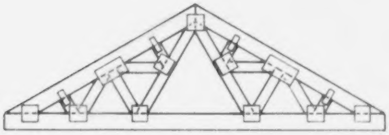
______j. Slight arch built into truss to prevent the member from eventually bending from its own weight in addition to the load it carries

1. Toothed ring
2. Camber
3. Tension web
4. Top chord
5. Split ring
6. Compression web
7. Bottom chord
8. Gang-nail plate
9. Truss
10. Glue-laminated arches

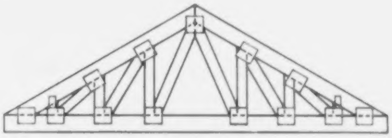
TEST

2. Identify the types of trusses illustrated. Write the correct names in the blanks.

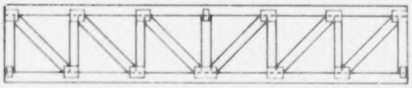
Flat Howe
King post
Flat warren
Modified
Pratt
Double W (WW) or Belgian
Flat pratt
Double Howe
Queen Post
Fan
Raised chord cambered fink
Saw tooth or monopitch
Multiple panel scissor
Fink or pitched
Modified queen-post
Howe scissor
Bowstring
Double Fink
Hip-louver
Standard Howe



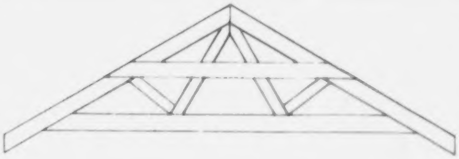
a. ______________________________



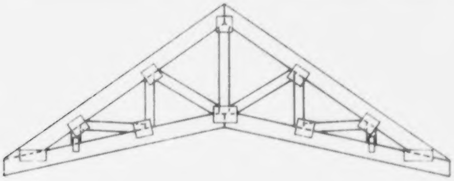
b. ______________________________



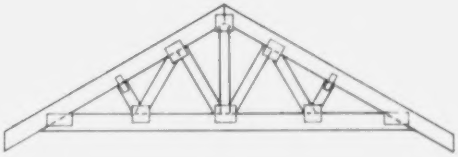
c. ______________________________



d. ______________________________

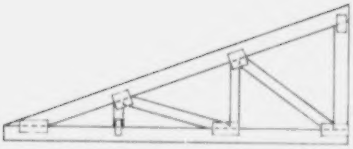


e. ______________________________

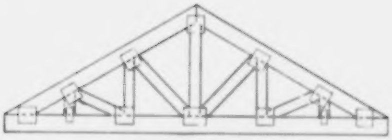


f. ______________________________

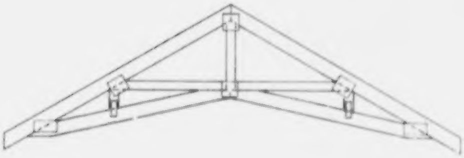
TEST



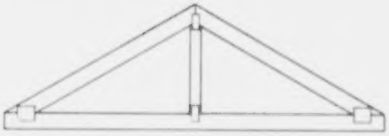
g. ______________________________



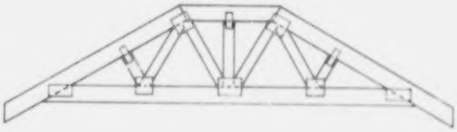
h. ______________________________



i. ______________________________



j. ______________________________



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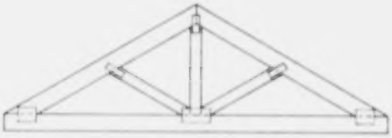

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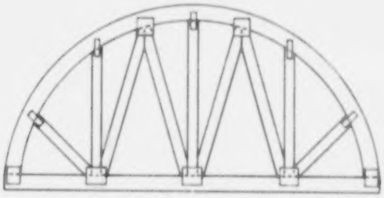

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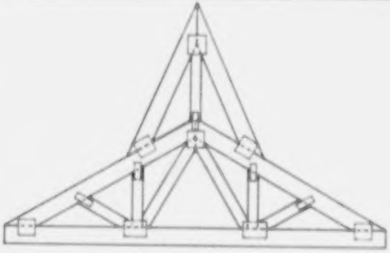
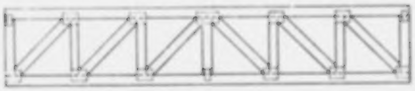
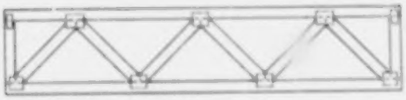


n. ______________________________

TEST



o. ______________________



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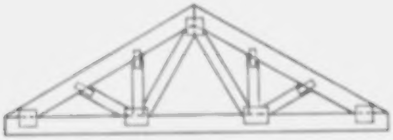
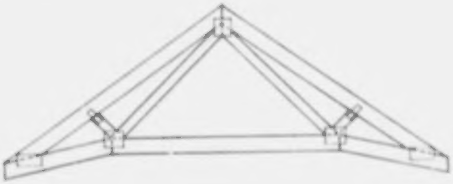


q. ______________________



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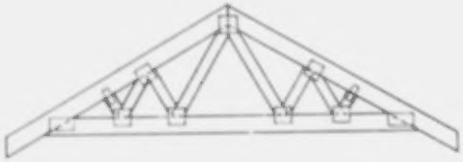
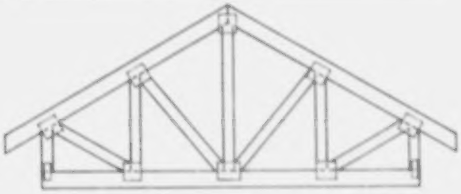
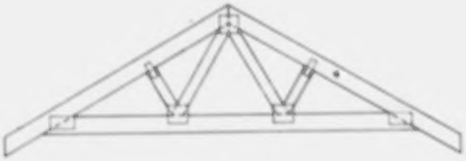


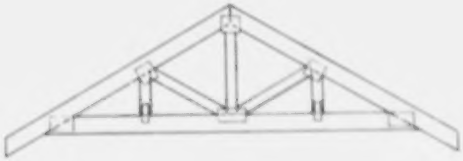
s. ______________________



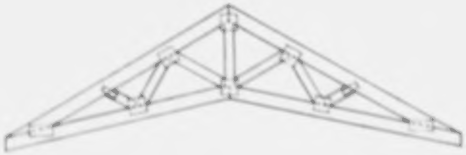
t. ______________________



u. ______________________



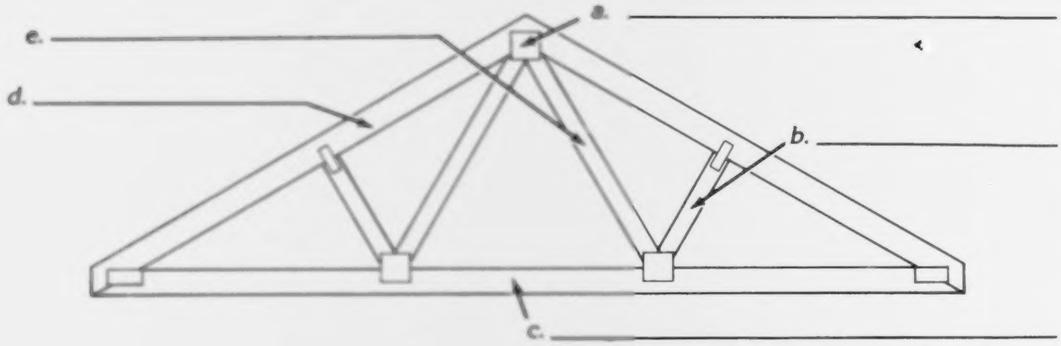
v. ______________________



w. ______________________

TEST

3. Label main parts of the truss illustrated. Write the correct names in the blanks.



4. Identify framing details illustrated. Write the correct numbers in the blanks.

______a. Pitched truss overhang with level return

______b. Flat truss mansard with cantilever, overhang and level return

______c. Flat truss with cantilever dropped

______d. Flat truss with top chord bearing on ledger

______e. Flat truss with interior beam bearing

______f. Flat truss cantilever

______g. Pitched truss cantilevered, overhang and level return

______h. Flat truss mansard with cantilever

______i. Flat truss mansard with parapet

______j. Flat truss with top chord bearing on exterior wall

______k. Flat truss with interior wall bearing

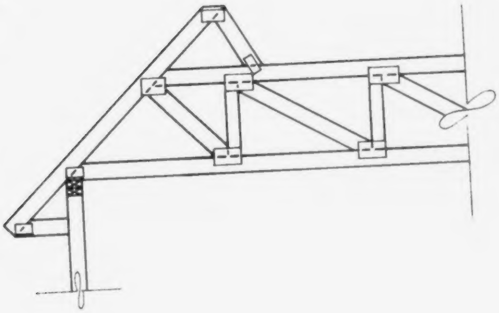
______l. Flat truss with bottom chord bearing on exterior wall

______m. Pitched truss cantilevered

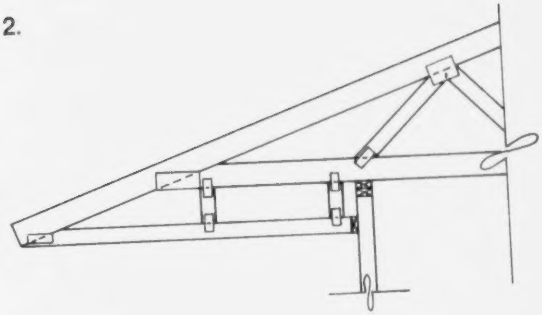
______n. Flat truss with overhang

TEST

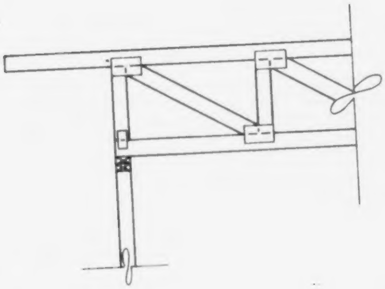
1.



2.



3.



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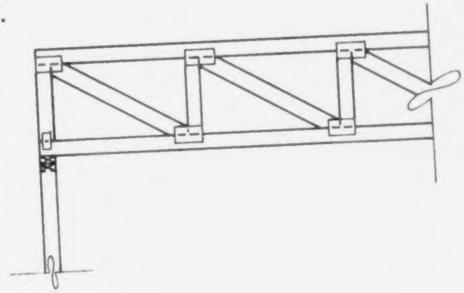

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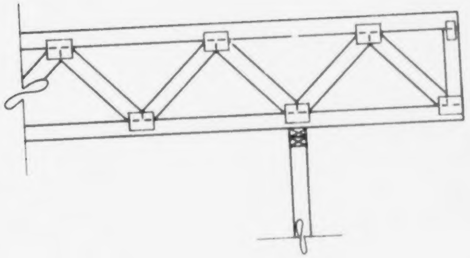

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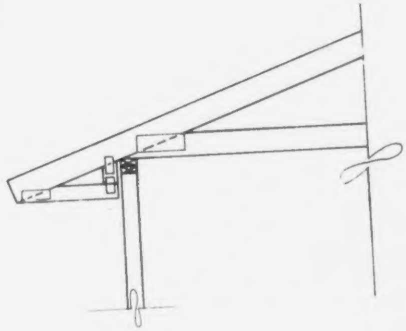

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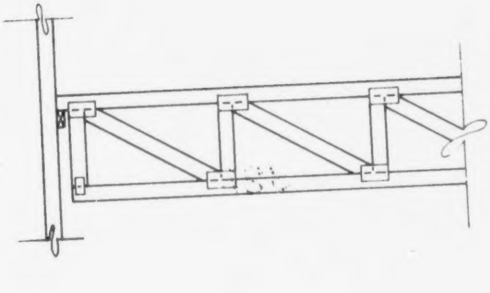

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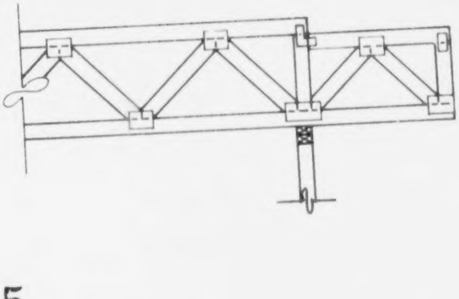
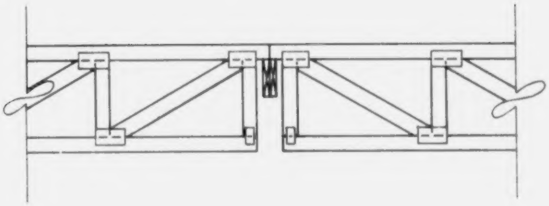


TEST

9.



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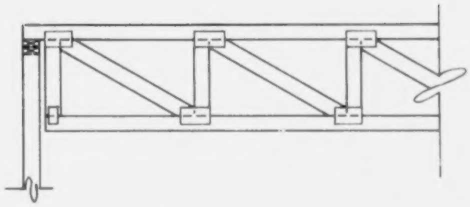

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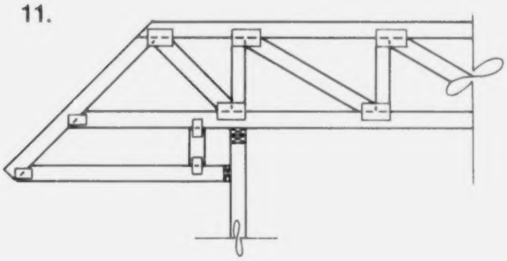

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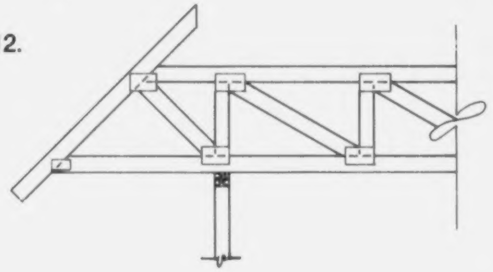

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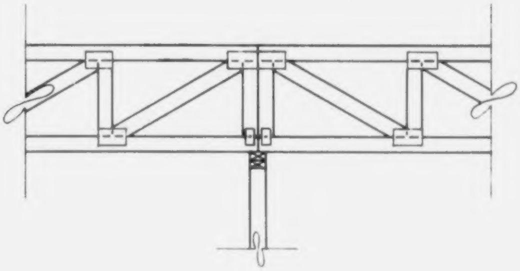

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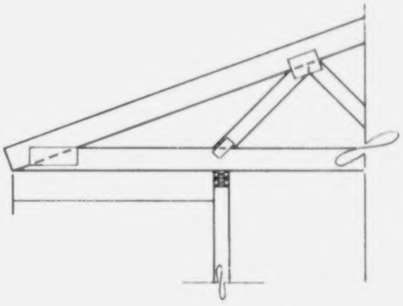
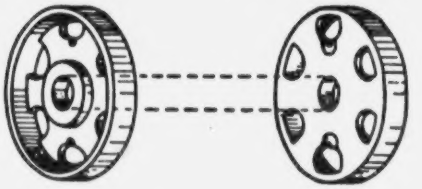
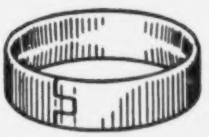


5. Identify hardware used in truss construction illustrated below.

Split ring
Toothed ring
Plate washer
Shear plate
Machine bolt
Malleable washer
Gang nail plate
Plywood gussett

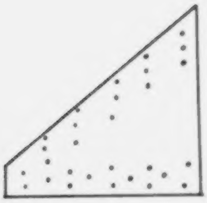


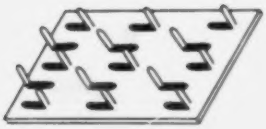
a. ______________________________



b. ______________________________

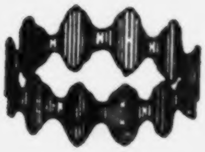
TEST

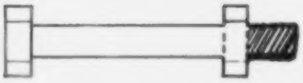




c. ______________________________

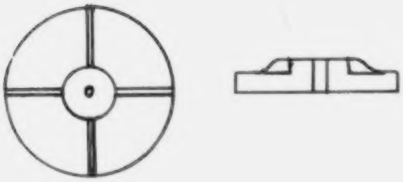
d. ______________________________

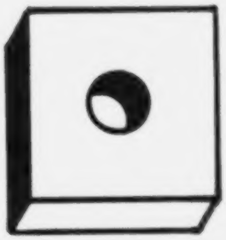




e. ______________________________

f. ______________________________





g. ______________________________

h. ______________________________

6. List four advantages of using trusses.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

TEST

7. State three considerations for weight and stress when designing trusses

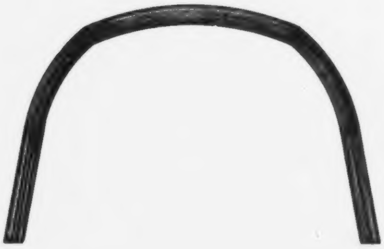
a. ____________________

b. ____________________

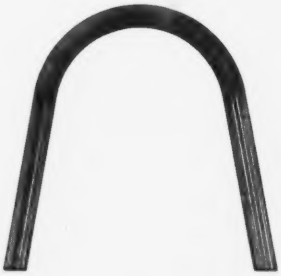
c. ____________________

8. Identify common types of glue laminated arches illustrated below. Write the correct names in the blanks.

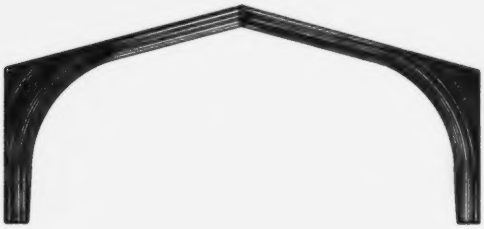
Radial Gothic **Three-Centered** **Tudor** **Parabolic** **A-Frame**



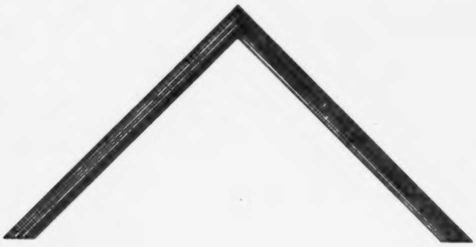
a. ____________________



b. ____________________

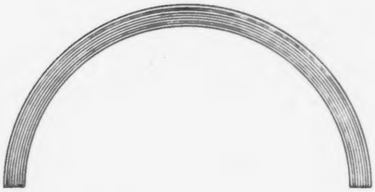


c. ____________________

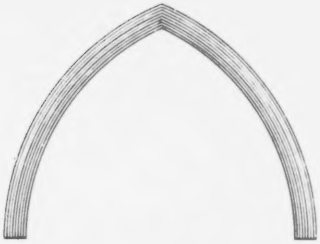


d. ____________________

TEST



e. ______________________________



f. ______________________________

(NOTE: Test question 9 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

9. Demonstrate the ability to

   a. Construct a standard howe truss.

   b. Erect trusses by hand.

   c. Erect trusses with light crane.

   d. Apply roof sheathing.

TRUSSES
UNIT IV

ANSWERS TO TEST

1. a. 6
   b. 10
   c. 1
   d. 4
   e. 8
   f. 3
   g. 9
   h. 7
   i. 5
   j. 2

2. a. Double fink
   b. Pratt
   c. Flat pratt
   d. Hip louver
   e. Double Howe scissor
   f. Modified queen post (Multiple panel)
   g. Monopitch
   h. Double Howe
   i. Howe scissor
   j. King post
   k. Hip
   l. Queen post
   m. Bowstring
   n. Piggyback
   o. Flat Howe
   p. Flat warren
   q. Fan
   r. Raised chord cambered fink
   s. Double-W (WW) or Belgian
   t. Modified
   u. Fink
   v. Standard Howe
   w. Multiple panel scissor

3. a. Gang nail plate
   b. Compression web
   c. Bottom chord
   d. Top chord
   e. Tension web

4. a. 6
   b. 11
   c. 8
   d. 7
   e. 9
   f. 5
   g. 2
   h. 12
   i. 1
   j. 10
   k. 13
   l. 4
   m. 14
   n. 3

5. a. Shear plate
   b. Split ring
   c. Plywood gusset
   d. Gang nail plate
   e. Toothed ring
   f. Machine bolt
   g. Malleable washer
   h. Plate washer

6. Any four of the following is correct

   a. Spans wide spans without support
   b. Labor saving
   c. Structually sound
   d. Open web type provides fast installation for mechanical trades
   e. Reliable performance
   f. Esthetic values on laminated finish type
   g. Allows more freedom in planning of interior space

ANSWERS TO TEST

7. Any three of the following is correct

    a. Weight of truss framework material
    b. Roof sheathing
    c. Roof finish materials
    d. Finish ceiling materials
    e. Local snow conditions
    f. Local wind conditions

8. a. Three-Centered
    b. Parabolic
    c. Tudor
    d. A-Frame
    e. Radial
    f. Gothic

9. Performance skills evaluated to the satisfaction of the instructor.

STRUCTURAL TIMBER CONSTRUCTION
UNIT V

UNIT OBJECTIVE

After completing this unit, the student should be able to apply principles of structural timber construction. The student will show this knowledge by completing the job sheet and unit test with a minimum of 85 percent accuracy.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with structural timber construction to their correct definitions.
2. List types of buildings in which structural timber construction is used.
3. Identify the basic components used in structural timber construction.
4. List factors that have contributed to the more efficient use of structural timber in modern construction.
5. List factors that determine the size of the components in structural timber construction.
6. Identify connecting devices used with structural timbers.
7. Identify hardware items used in structural timber construction.
8. Identify types of decking.
9. Demonstrate the ability to construct a structural timber picnic shelter.

STRUCTURAL TIMBER CONSTRUCTION
UNIT V

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency masters

    1. TM #1 — Components of Structural Timber Construction

    2. TM #2 — Connecting Devices

    3. TM #3 — Connecting Devices (Continued)

    4. TM #4 — Connecting Devices (Continued)

    5. TM #5 — Connecting Devices (Continued)

    6. TM #6 — Connecting Devices (Continued)

    7. TM #7 — Hardware Items

    8. TM #8 — Types of Decking

    9. TM #9 — Glue-Laminated Beams

  D. Information sheet

  E. Job Sheet #1 — Construct a Structural Timber Picnic Shelter

  F. Test

  G. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain materials necessary to supplement presentation.

    1. Equipment and materials for procedures outlined in job sheet

    2. Transparencies and competency profiles

SUGGESTED ACTIVITIES

(NOTE: Transparencies and competency profiles for this manual are available from the Curriculum and Instructional Materials Center, State Department of Vocational and Technical Education, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

3. Pamphlets, brochures, etc.

(NOTE: Information is available from the American Institute of Timber Construction, 333 W. Hampden Avenue, Englewood, Colorado 80110; phone 303-761-3212.)

C. Introduce unit.

SUGGESTIONS:

- Show students pictures of structures built with timbers, both solid and glue-laminated
- Discuss reasons for using such materials providing students with actual steel beams, dimensional lumber, and timbers that have been in a fire or pictures of such materials

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information sheet.

G. Discuss information sheet.

1. Use Information Sheet, Section I to discuss terms associated with structural timber construction.

SUGGESTION:

- Use actual examples or pictures to illustrate materials included in the terms.

2. Use Information Sheet, Section II to discuss types of buildings in which structural timber construction is used.

SUGGESTIONS:

- Explain what is meant by each type of structure.
- Show pictures of or visit each type of structure using timber construction.

SUGGESTED ACTIVITIES

- Discuss applications of structural timber construction and describe how these may be used and may appear in each type of building.

  EXAMPLES: Concealed framing, exposed framing, horizontal or vertical framing.

3. Use Information Sheet, Section III and Transparency 1 to discuss components of structural timber construction

   SUGGESTIONS:

   - Build a model using the basic components that can be easily assembled and disassembled.

   - Visit a construction site where the basic components are being used.

4. Use Information Sheet, Section IV to discuss factors that have contributed to the move efficient use of structural timber in modern construction.

   SUGGESTIONS:

   - Invite a structural timber manufacturer or distributor to discuss structural timber construction with the class, emphasizing the factors listed.

   - Provide the class with pamphlets and other information that stress the four factors.

     EXAMPLES: Manufacturer's brochures, hardware catalogs, information on wood preservatives

5. Use Information Sheet, Section V to discuss factors determining the size of components in structural timber construction.

   SUGGESTIONS:

   - Use the model you built or a drawing to illustrate load, span, and other forces acting upon structural members.

   - Obtain a span chart that compares grade and species of lumber, such as those used by truss manufacturers.

6. Use Information Sheet, Section VI and Transparencies 2 through 6 to discuss connecting devices

   SUGGESTIONS:

   - Show the class examples of each type of connector; show availability of styles and size with catalogs

SUGGESTED ACTIVITIES

- Discuss the principles and applications associated with each type of connector.

7. Use Information Sheet, Section VII and Transparency 7 to discuss hardware used in structural timber construction.

   SUGGESTIONS:

   - Show the class examples of each type of hardware.
   - Discuss applications and installation methods involved with each type.
   - Discuss sizes, requirements for drilling, requirements for washers, and other factors to consider in hardware installation.
   - Demonstrate the installation of various types of hardware, emphasizing those used in your area.

8. Use Information Sheet, Section VIII and Transparencies 8 and 9 to discuss types of decking and glue-laminated beams.

   SUGGESTIONS:

   - Show students examples of each type of decking and beam.
   - Discuss reasons for using each type of decking in specific applications.
   - Demonstrate the assembly and installation of each type of decking.

H. Provide students with Job Sheet #1 and with the plans for the structure.

SUGGESTIONS:

- Discuss the plans and relate the concepts studied in the information sheet to the plans, such as the types of connectors and hardware to use, sizes of timbers, types of decking, etc.
- Demonstrate the procedures involved in the construction process.

I. Allow students to practice the job sheet procedures.

J. Review unit.

K. Give test.

L. Critique test with class.

M. Reteach and retest as necessary.

N. Complete appropriate portions of competency profiles.

SUGGESTED ACTIVITIES

III. Unit references

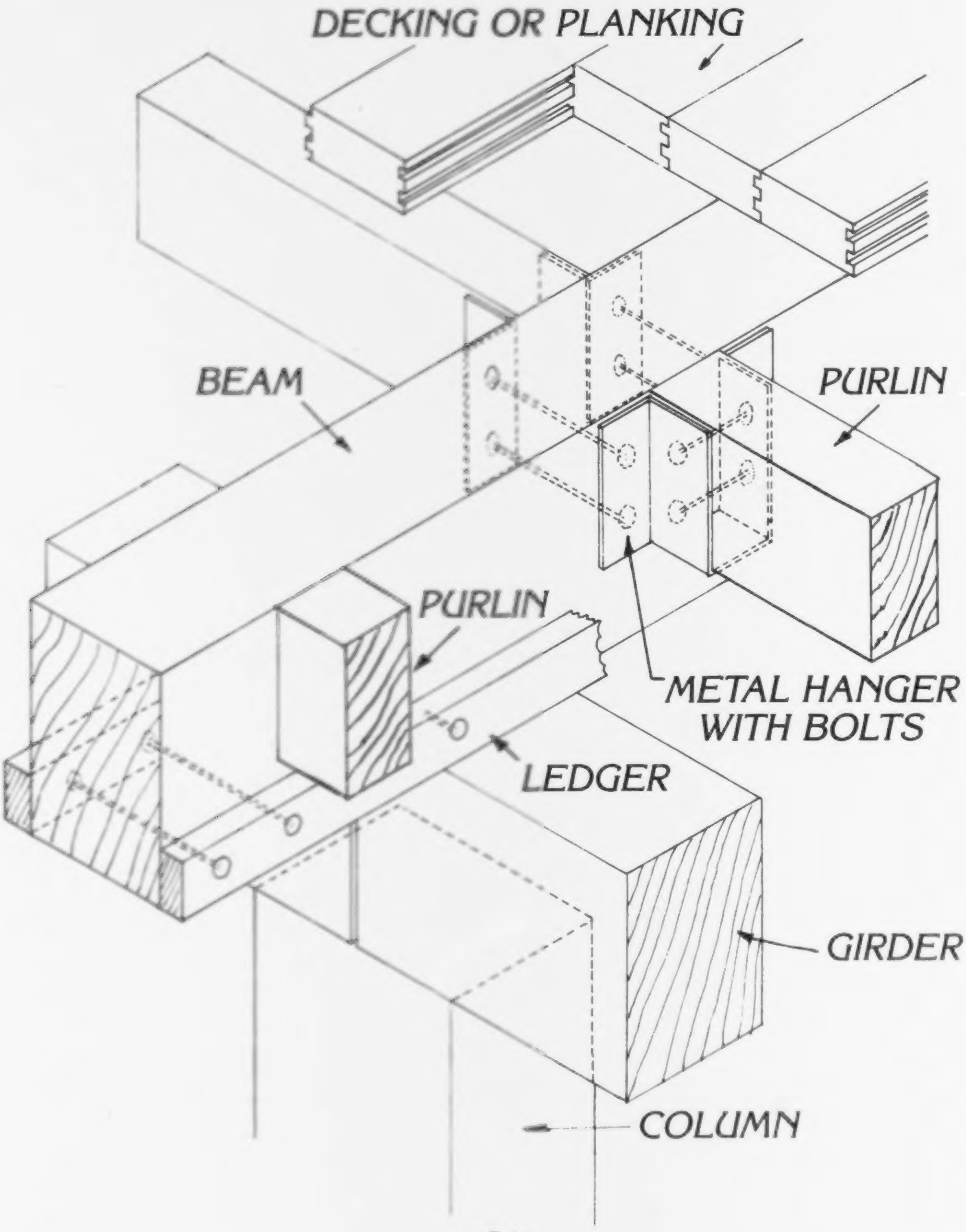
A. Burke, Arthur E., J. Ralph Dalzell and Gilbert Townsend. *Architectural and Building Dictionary.* Chicago: American Technical Society, 1955.

B. Hendrix, Laborn J. "Bud." *Commercial Carpentry.* Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1979.

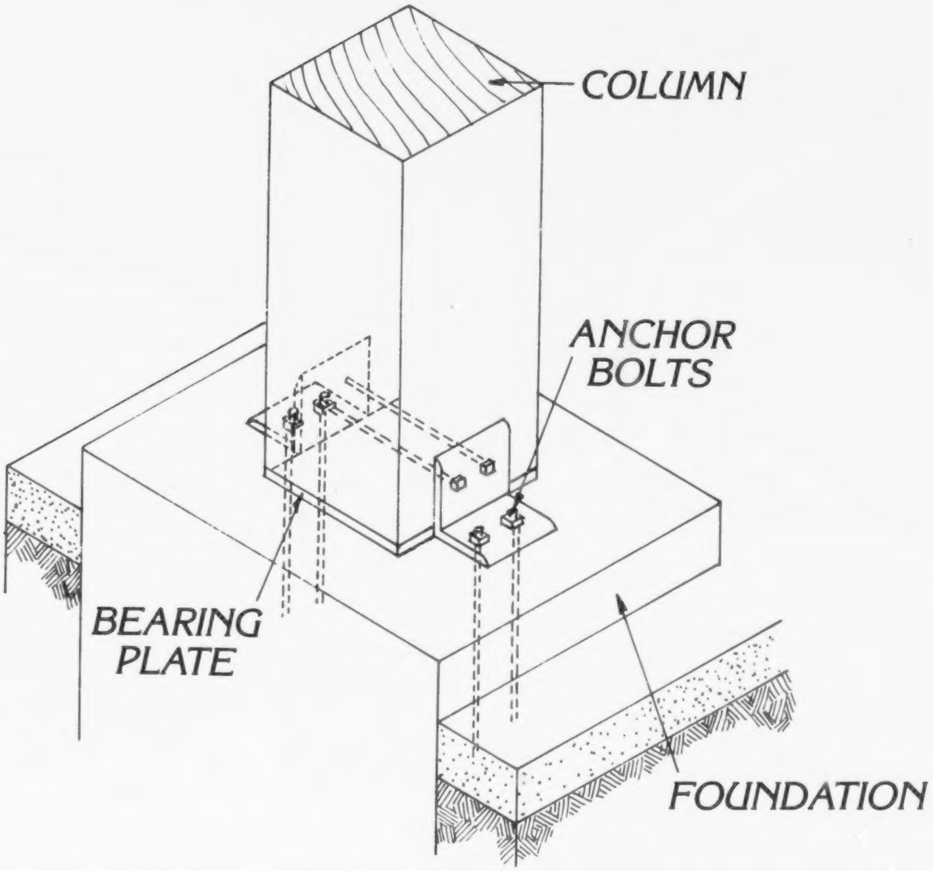
C. Ramsey, Charles G., and Harold R. Sleeper. *Architectural Graphic Standards.* 6th ed. New York: John Wiley and Sons, Inc., 1970.

D. Smith, Ronald C. *Principles and Practices of Heavy Construction.* Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1970.

Components of Structural Timber Construction

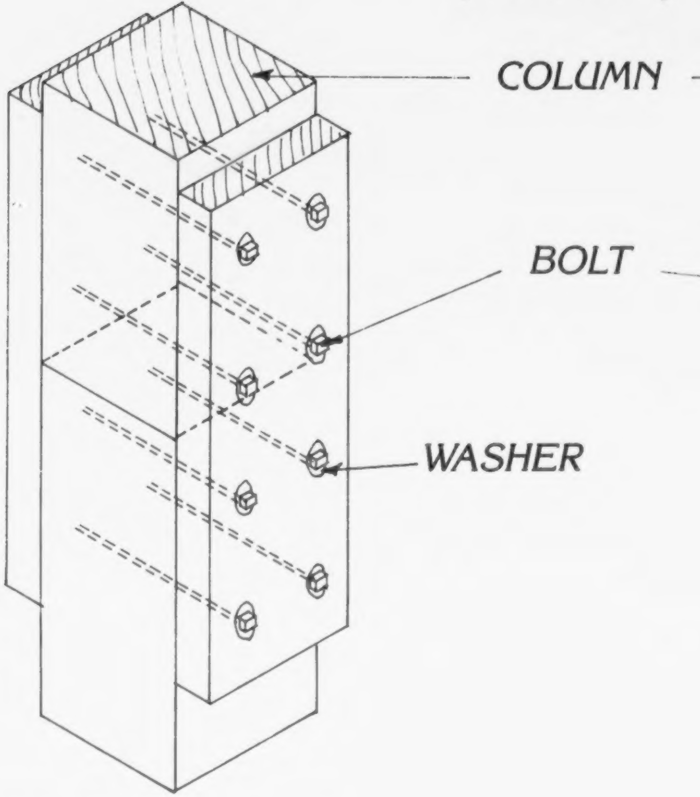

DECKING OR PLANKING
BEAM
PURLIN
PURLIN
METAL HANGER WITH BOLTS
LEDGER
GIRDER
COLUMN

Connecting Devices

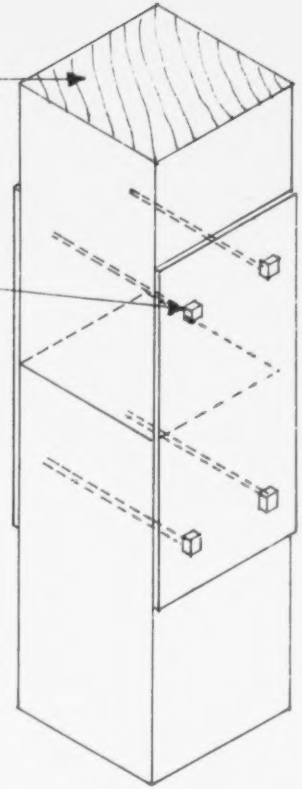

COLUMN
ANCHOR BOLTS
BEARING PLATE
FOUNDATION

METAL ANGLE WITH BOLTS

Connecting Devices
(Continued)

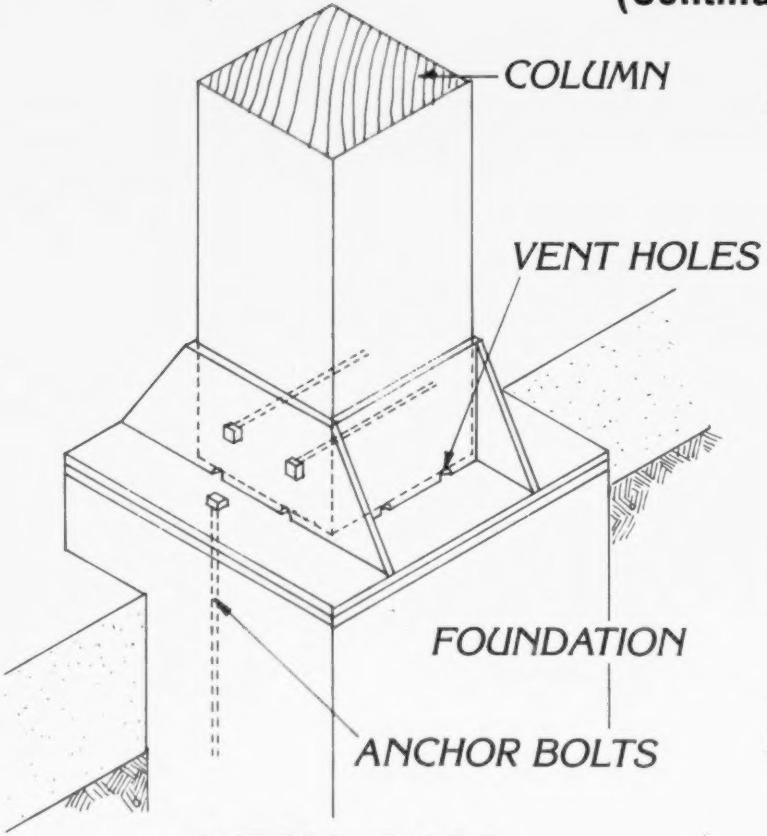

COLUMN
BOLT
WASHER

WOOD SPLICE
PLATE WITH BOLTS

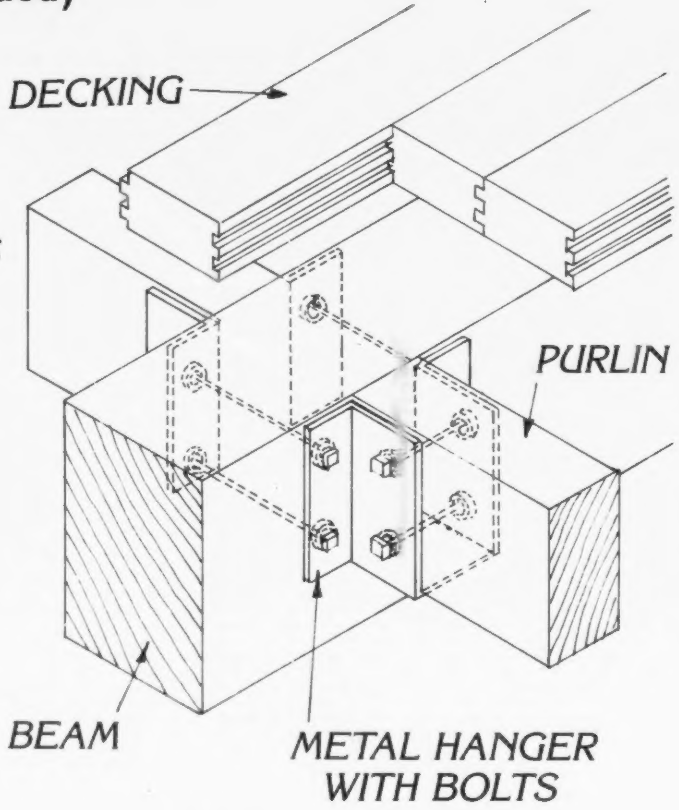


METAL SPLICE
PLATE WITH BOLTS

Connecting Devices
(Continued)

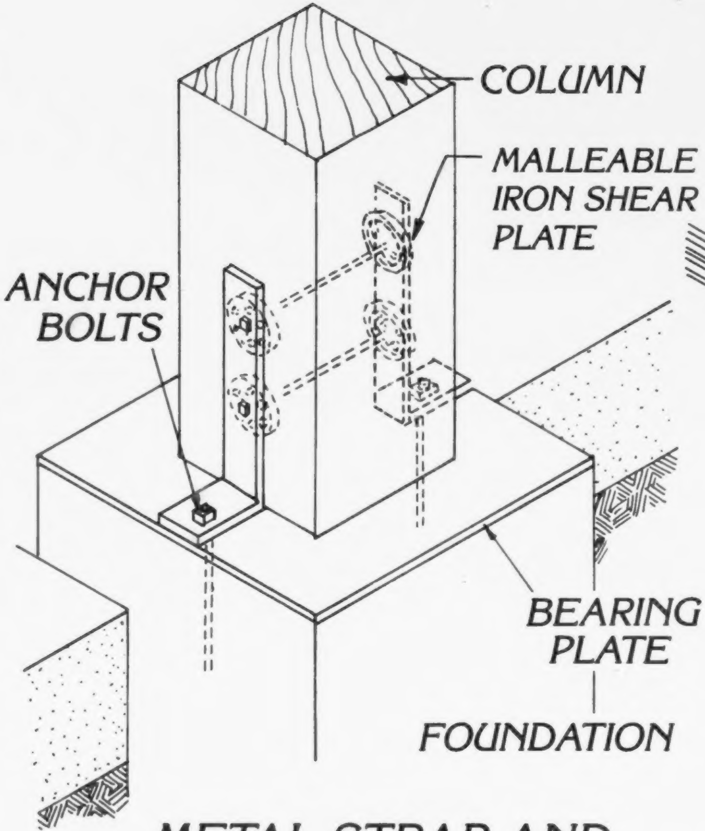

COLUMN
VENT HOLES
FOUNDATION
ANCHOR BOLTS

METAL SHOE CONNECTION

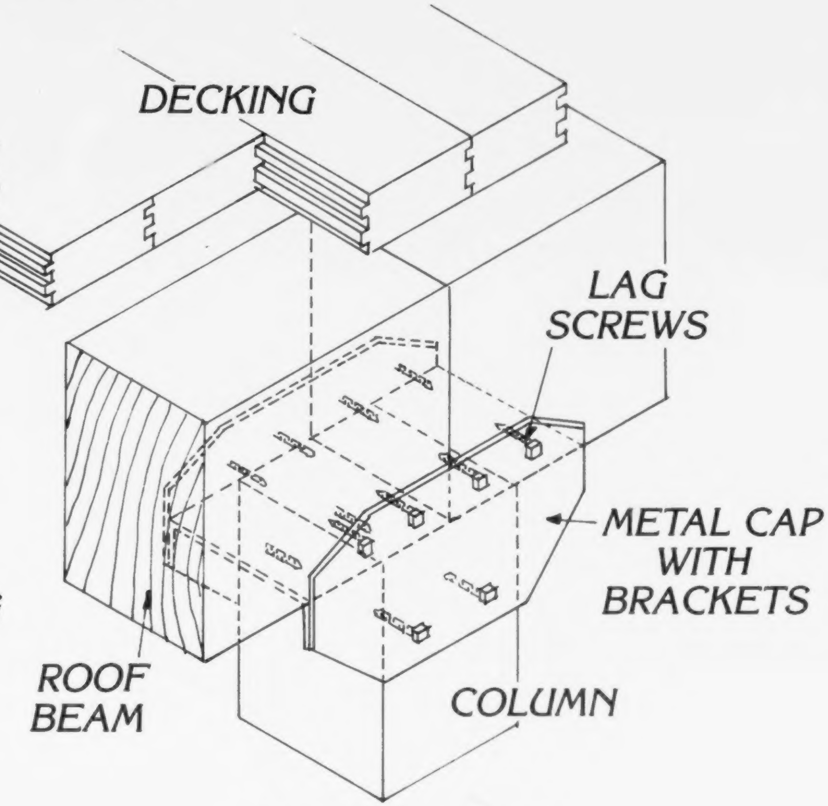

DECKING
PURLIN
BEAM
METAL HANGER WITH BOLTS

METAL HANGER

Connecting Devices
(Continued)


COLUMN
MALLEABLE IRON SHEAR PLATE
ANCHOR BOLTS
BEARING PLATE
FOUNDATION

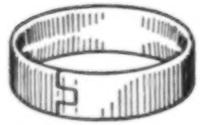
METAL STRAP AND SHEAR PLATE CONNECTION


DECKING
LAG SCREWS
METAL CAP WITH BRACKETS
ROOF BEAM
COLUMN

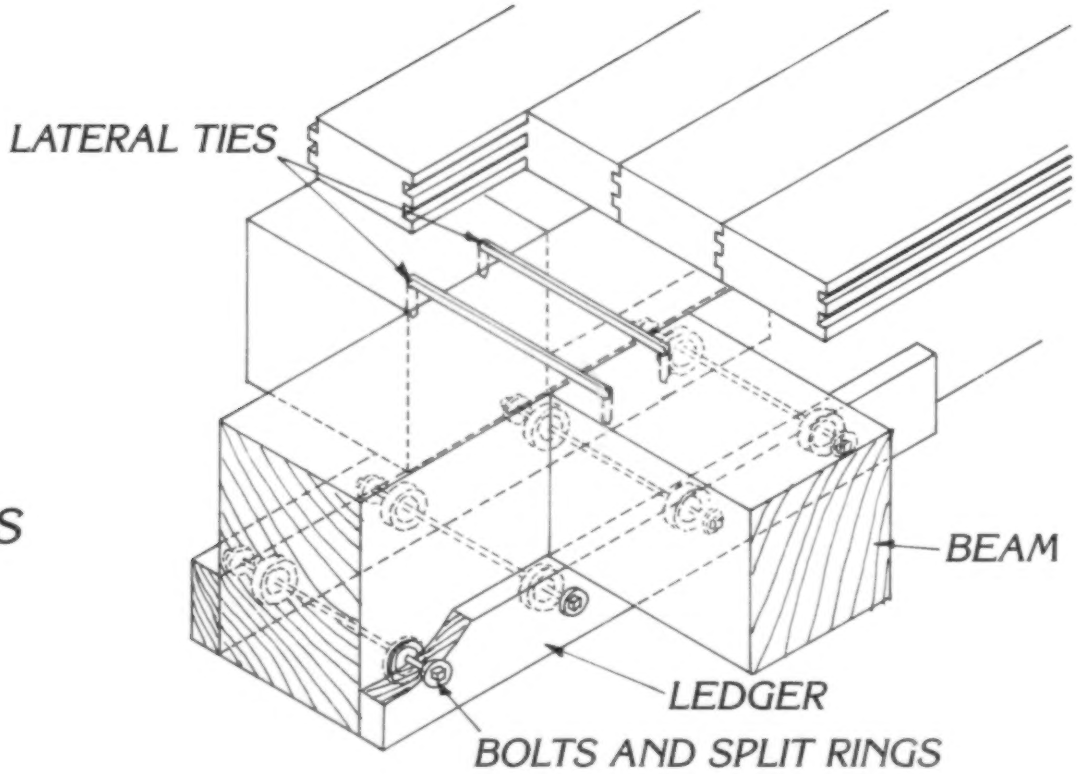
COLUMN CAP

Connecting Devices

(Continued)

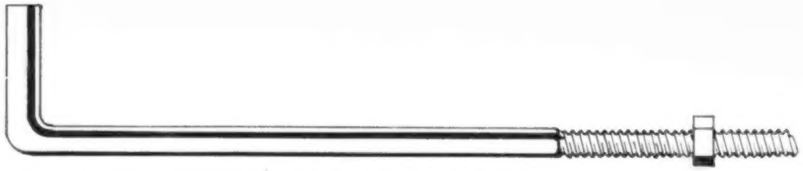


SPLIT RINGS

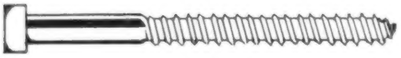

LATERAL TIES
BEAM
LEDGER
BOLTS AND SPLIT RINGS

LATERAL TIES

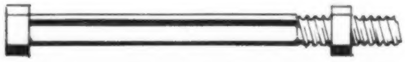
Hardware Items



ANCHOR BOLT



LAG SCREW



MACHINE BOLT

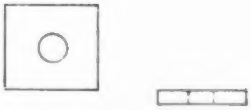
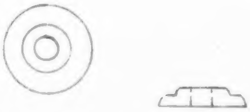
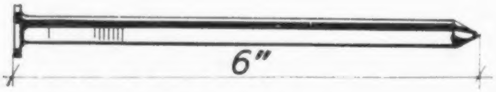


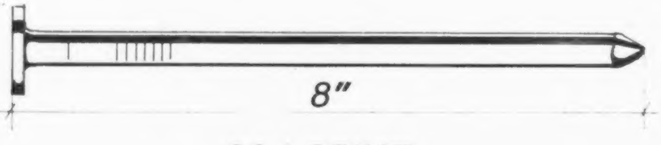
PLATE WASHER



MALLEABLE WASHER

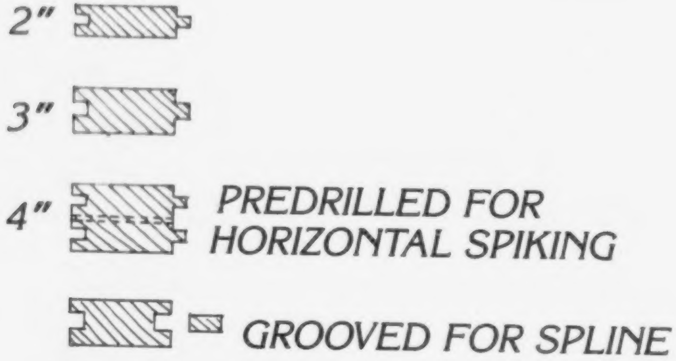


20d SPIKE

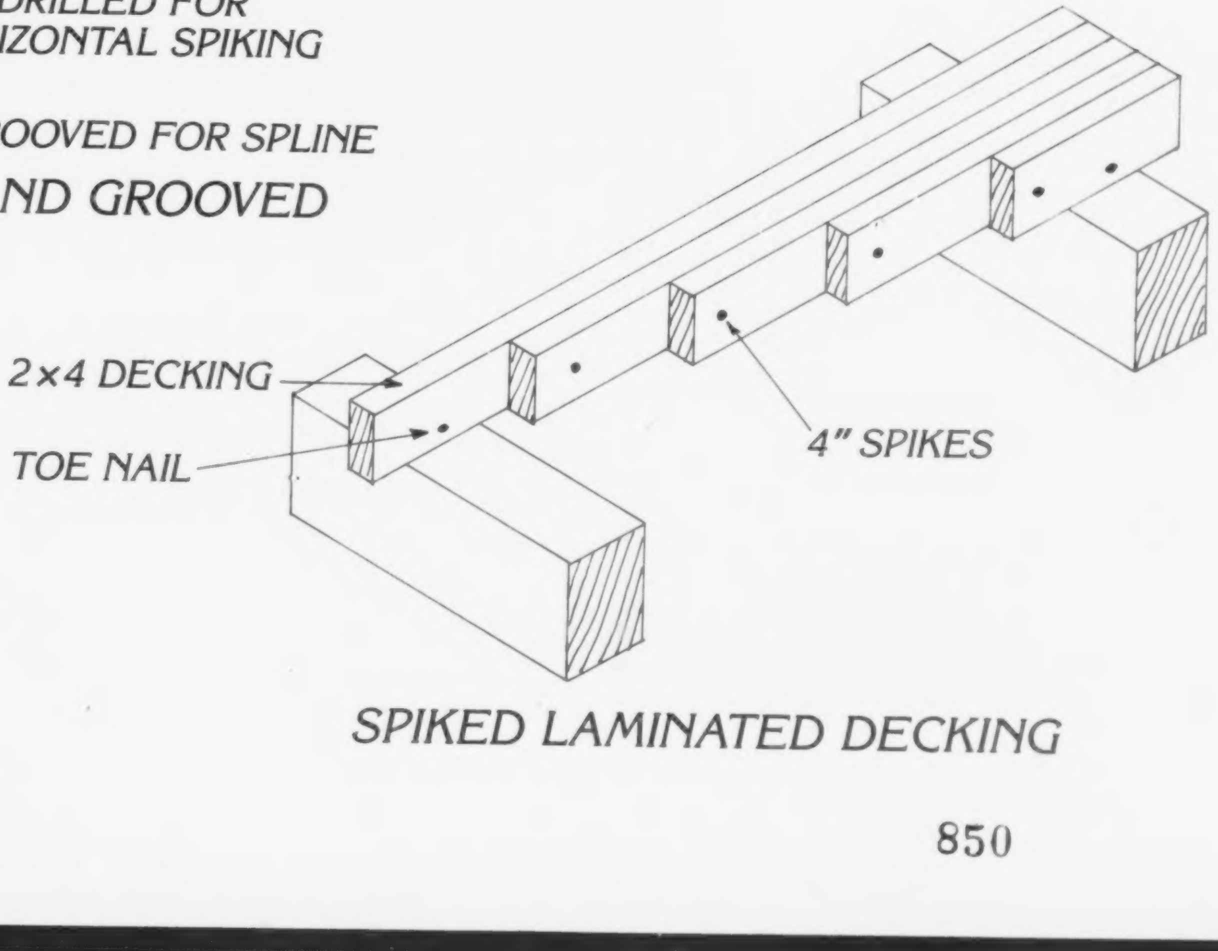


80d SPIKE

Types of Decking

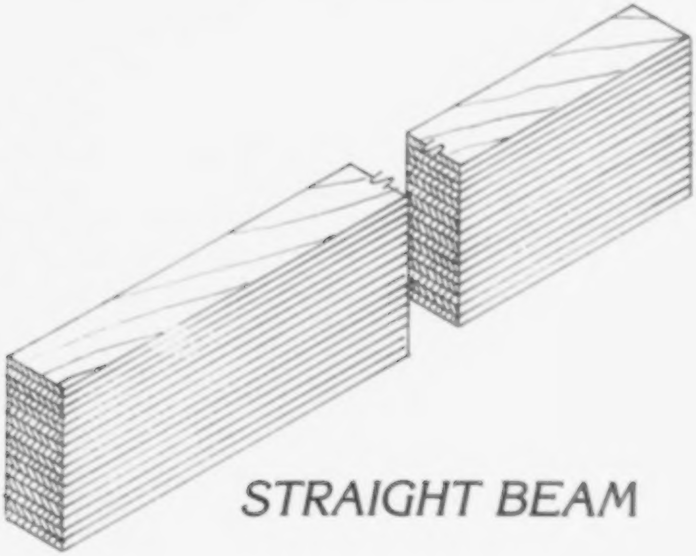

2"
3"
4"
PREDRILLED FOR HORIZONTAL SPIKING
GROOVED FOR SPLINE

TONGUE AND GROOVED

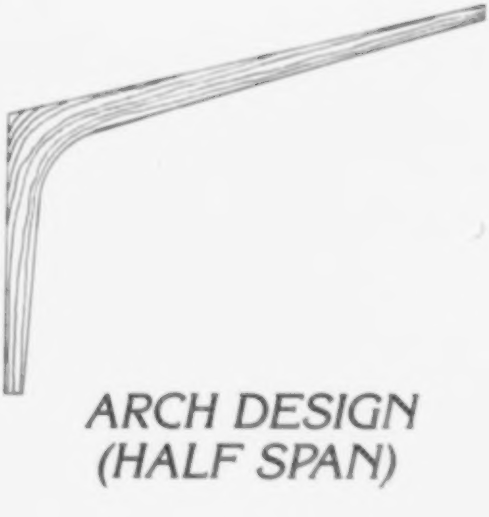

2×4 DECKING
TOE NAIL
4" SPIKES

SPIKED LAMINATED DECKING

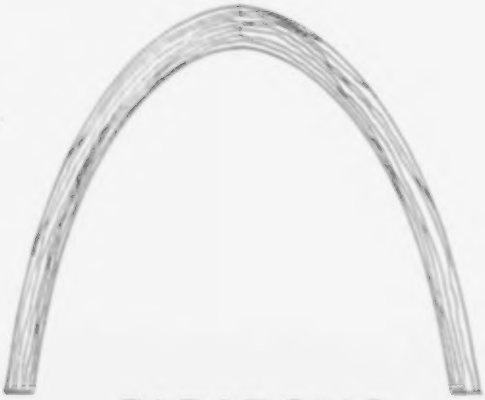
Glue-Laminated Beams



STRAIGHT BEAM



ARCH DESIGN
(HALF SPAN)



PARABOLIC
ARCH DESIGN

STRUCTURAL TIMBER CONSTRUCTION
UNIT V

INFORMATION SHEET

I. Terms and definitions

A. Heavy timber construction — Type of construction whose structural system is composed of solid stock or glue-laminated timbers which offer a significant degree of fire resistance by limiting the minimum cross-sectional dimension of members and decking

B. Wood beam — Timber or glue-laminated member used in a horizontal position to transfer floor or roof loads to columns

C. Decking — Any lumber generally 2" or thicker laid as the roof or floor of a structure

D. Connection — Mechanical means of connecting timbers to each other or to a fixed object

E. Split ring — Steel ring with a tongue and groove split in the band

F. Shear plate — Round steel plate used primarily for connecting wood to non-wood

G. Wood column — Timbers or glue-laminated timbers used in vertical position to support beams

H. Purlin — Horizontal timbers supporting the common rafters in a roof

I. Laminate — To make by uniting superimposed layers of one or more materials

J. Glue-laminated beam — Engineered, stress-rated product of wood laminations securely bonded together with adhesives

II. Types of buildings in which structural timber construction is used

A. Industrial

B. Commercial

C. Institutional

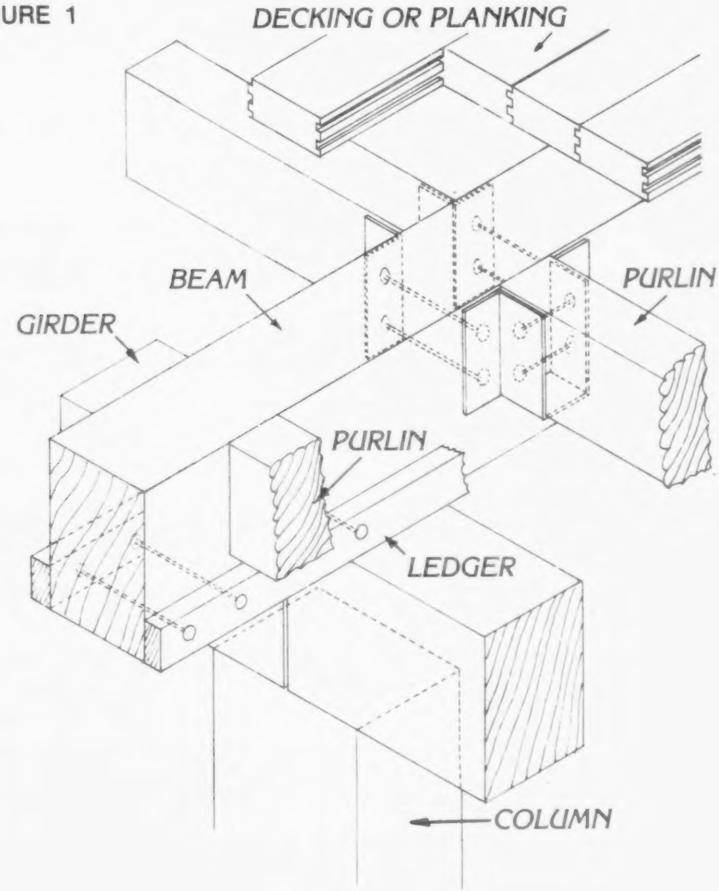
D. Recreational

E. Residential

INFORMATION SHEET

III. Components used in structural timber construction (Figure 1)

FIGURE 1


DECKING OR PLANKING
BEAM
PURLIN
GIRDER
PURLIN
LEDGER
COLUMN

IV. Factors contributing to more efficient use of structural timber in modern construction

A. Development and refinement of stress-graded timber, both solid and glue-laminated

B. Production of modern types of timber connectors

C. Full recognition of fire resistance of larger timber sections

D. Use of preservatives to help timber withstand the deteriorating effects of moisture, disease, and insects

INFORMATION SHEET

V. Factors determining size of components in structural timber construction

  A. Load

  B. Span of girders, beams, and decking

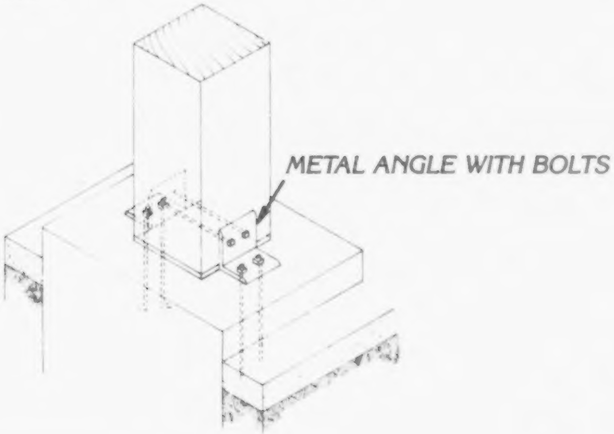
  C. Unsupported height of columns

  D. Grade and species of timber

VI. Connecting devices used with structural timbers (Figures 2-11)

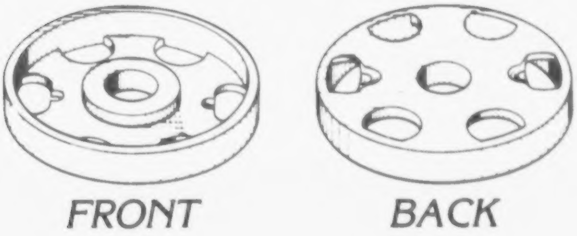
  A. Metal angle with bolts

FIGURE 2



  B. Malleable iron shear plate

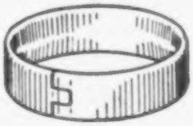
FIGURE 3



INFORMATION SHEET

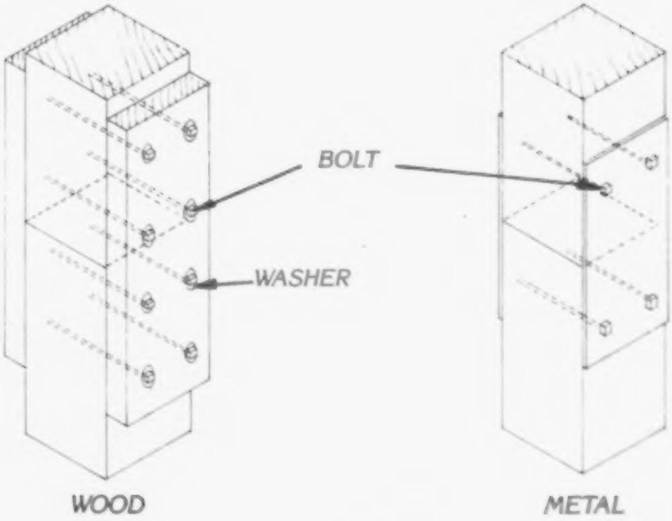
C. Split ring

FIGURE 4



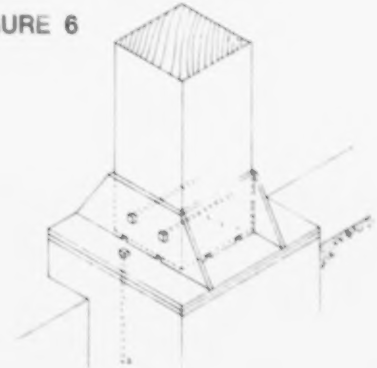
D. Splice plates with bolts and washers

FIGURE 5


BOLT
WASHER
WOOD
METAL

E. Metal shoe connection

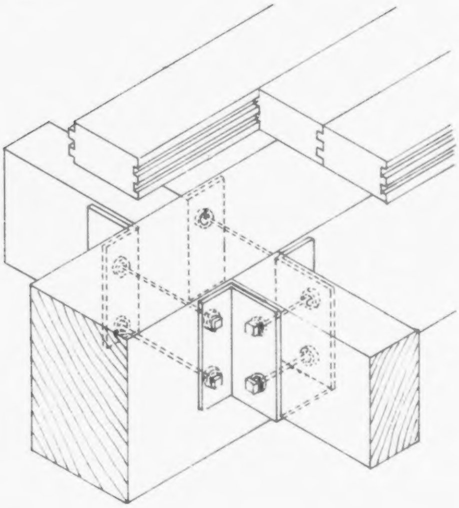
FIGURE 6



INFORMATION SHEET

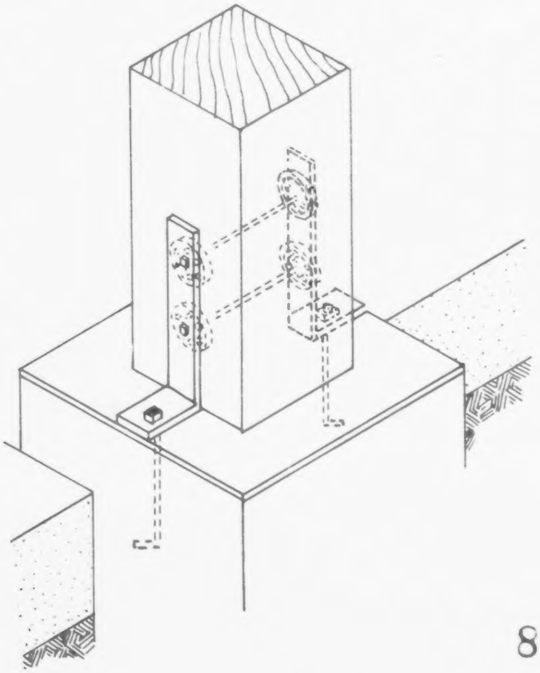
F. Metal hangers with bolts

FIGURE 7



G. Metal strap and shear plate connection

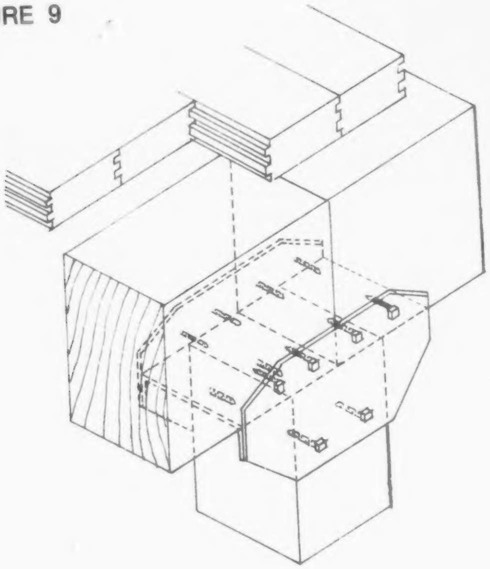
FIGURE 8



INFORMATION SHEET

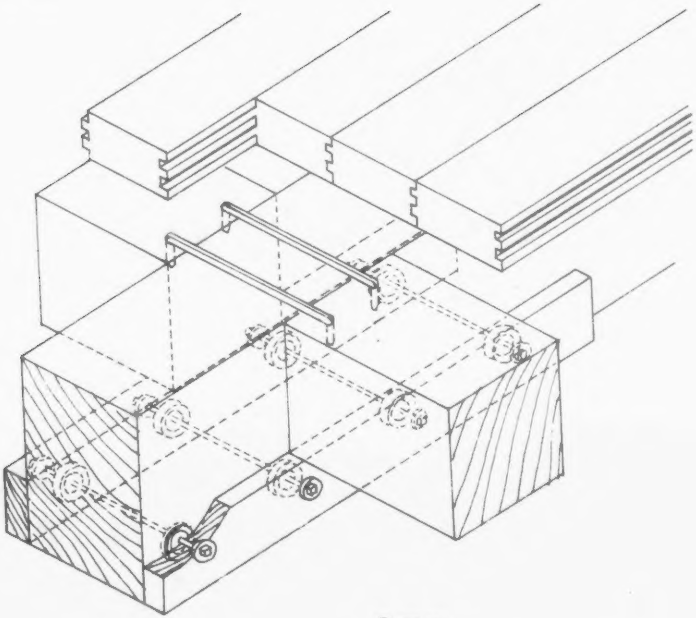
H. Column cap

FIGURE 9



I. Lateral ties

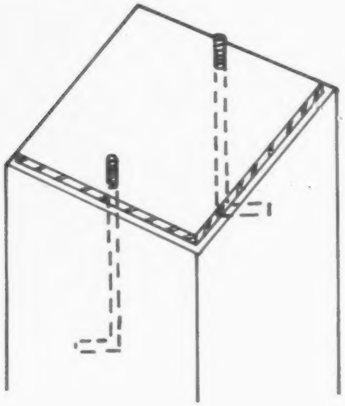
FIGURE 10



INFORMATION SHEET

J. Bearing plate and anchor bolts

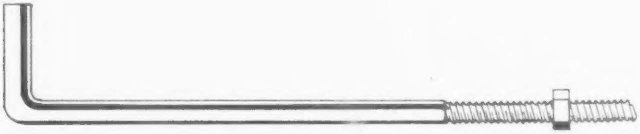
FIGURE 11



VII. Hardware items used in structional timber construction (Figures 12-18)

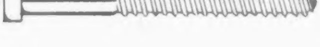
A. Anchor bolt

FIGURE 12



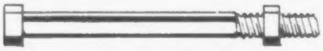
B. Lag screw

FIGURE 13



C. Machine bolt

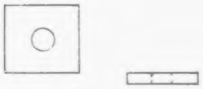
FIGURE 14



INFORMATION SHEET

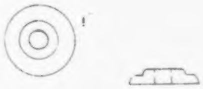
D. Plate washer

FIGURE 15



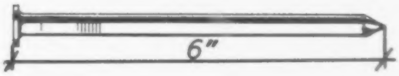
E. Malleable washer

FIGURE 16



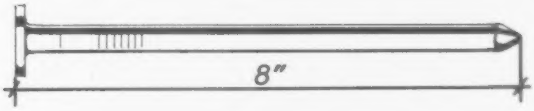
F. 20d spikes

FIGURE 17



G. 80d spike

FIGURE 18



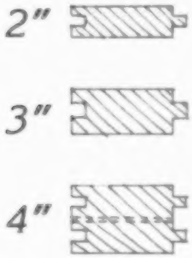
INFORMATION SHEET

VIII. Types of decking (Figures 19-21)

(NOTE: Three-inch and four-inch decking may be predrilled for horizontal nailing.)

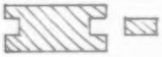
A. Tongue and groove

FIGURE 19



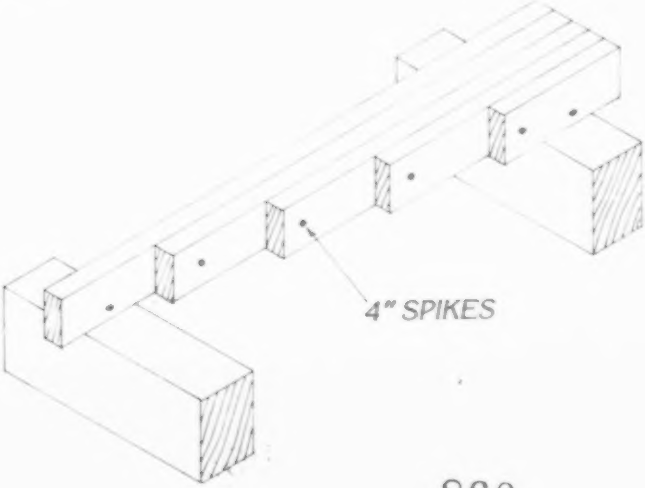
B. Grooved for spline

FIGURE 20



C. Laminated decking (job-site spiked or glue-laminated)

FIGURE 21



STRUCTURAL TIMBER CONSTRUCTION
UNIT V

JOB SHEET #1 — CONSTRUCT A STRUCTURAL TIMBER PICNIC SHELTER

I. Tools and equipment

  A. Framing square
  B. ½" electric drill motor
  C. Power hand saw
  D. Folding rule or steel tape
  E. Claw hammer
  F. Wood drill bites
  G. Extension cord
  H. 4' level and straight edge
  I. Combination open end and box end wrenches
  J. Ratchet and deep socket wrench set
  K. String line
  L. Common and duplex nails
  M. Bolts, nuts, and washers
  N. Allthread rods, nuts, and washers
  O. 2×4s for braces
  P. 6×6 timbers for posts, joists, and rafters
  Q. 4×6 timbers for collar braces
  R. 8×12 timber for ridge beam
  S. 2×6s and 2×8s for construction of saddles
  T. 16 steel "T" gusset plate
  U. 16 steel gusset plates
  V. 4 metal straps

JOB SHEET #1

W. 2×4 stakes

X. Chamfered filler strips

Y. Plans at end of job sheet

II. Procedure

(NOTE: The slab will have been poured, finished, and cured with anchor bolts and plates installed.)

A. Square ends of posts and cut to 8′ –0″ length

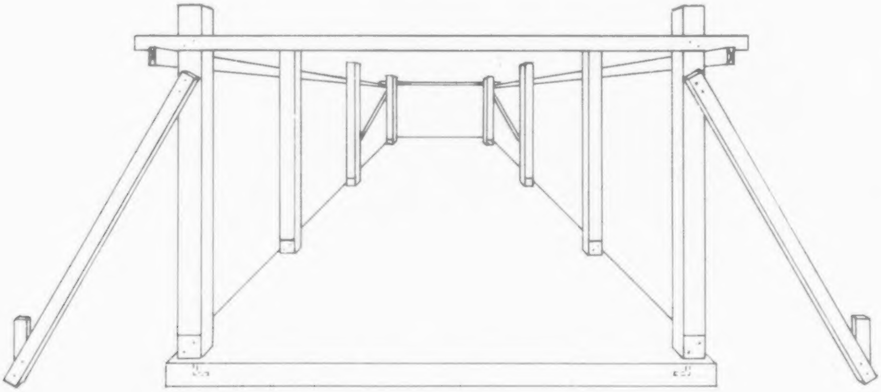
B. Drill posts to match holes in anchor plates

C. Place posts in anchor plates; plumb and bolt securely

D. Align parts by stretching a stringline from one corner post to opposite corner post on both sides of structure

E. Brace posts, being sure they are plumb in all directions (Figure 22)

FIGURE 22



F. Install joists

1. Measure and cut joists to length

2. Cut joist ends to match roof pitch (see plan)

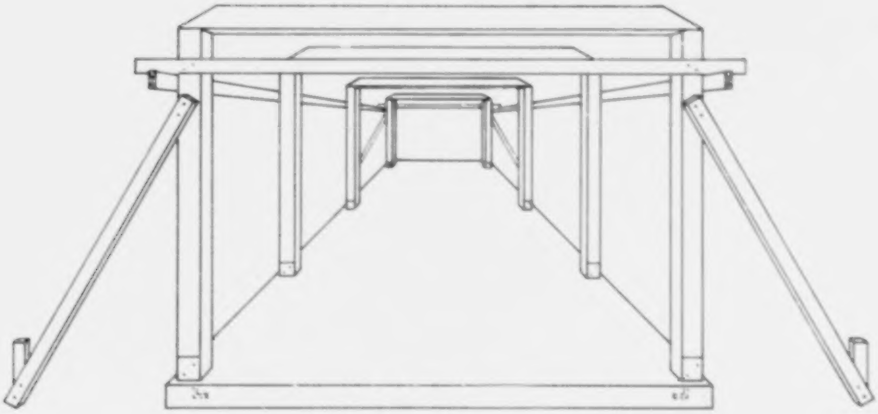
JOB SHEET #1

3. Place first joist on top of two posts and nail through top of joist into top of posts

   (NOTE: Be sure ends and edge of joist are flush with back and sides of post.)

4. Install remainder of joists (Figure 23)

FIGURE 23



G. Measure and cut ridge timber to length, allowing for 2′ overhang on gable ends

H. Construct three saddle braces as shown in detail

   1. Cut 2×8s to fit under ridge beam

   2. Nail 2×6s to 2×8s

      (NOTE: Let 2×6s extend end up past the ridge beam.)

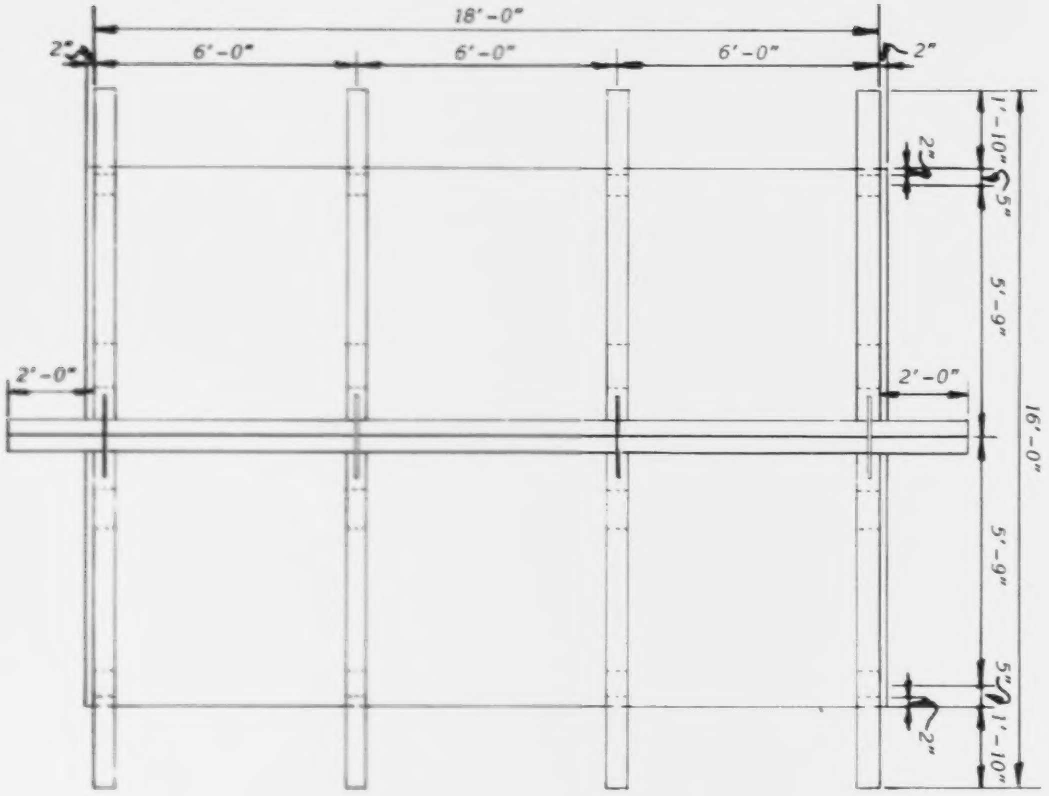
I. Measure in 2′–0″ from both ends of ridge beam and mark

   (NOTE: Measurement between these marks should be the exact length of building.)

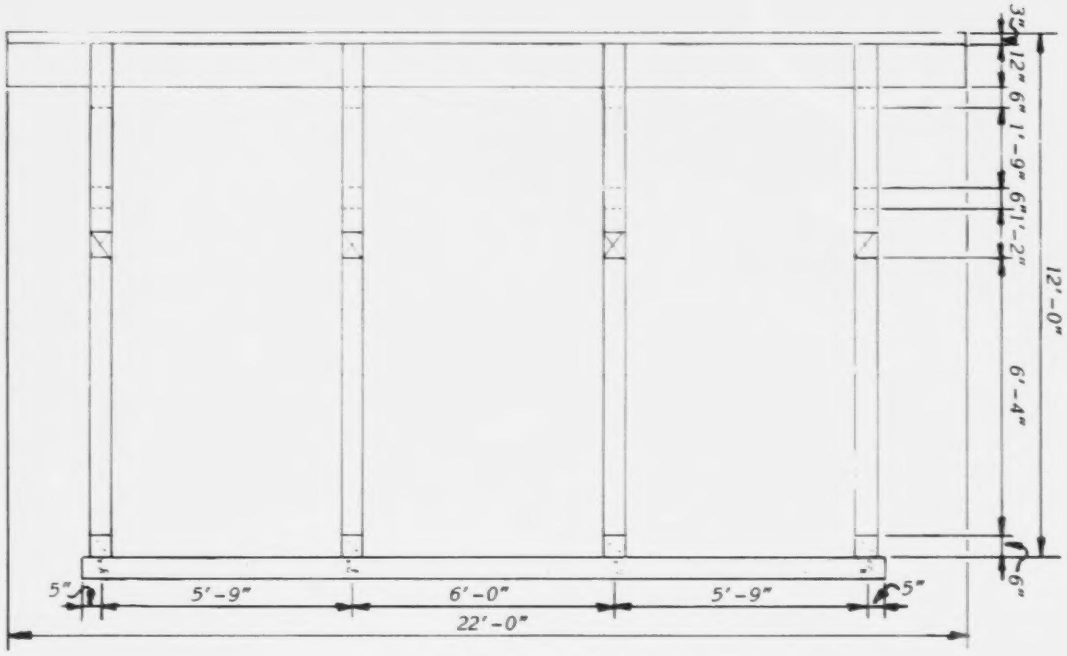
J. Erect saddles

   1. Locate centerline of width of building on slab

   2. Center saddles at each end of building


18'-0"
2"
6'-0"
6'-0"
6'-0"
2"
1'-10"
2"
5"
5'-9"
2'-0"
2'-0"
16'-0"
5'-9"
5"
2"
1'-10"

PLAN VIEW

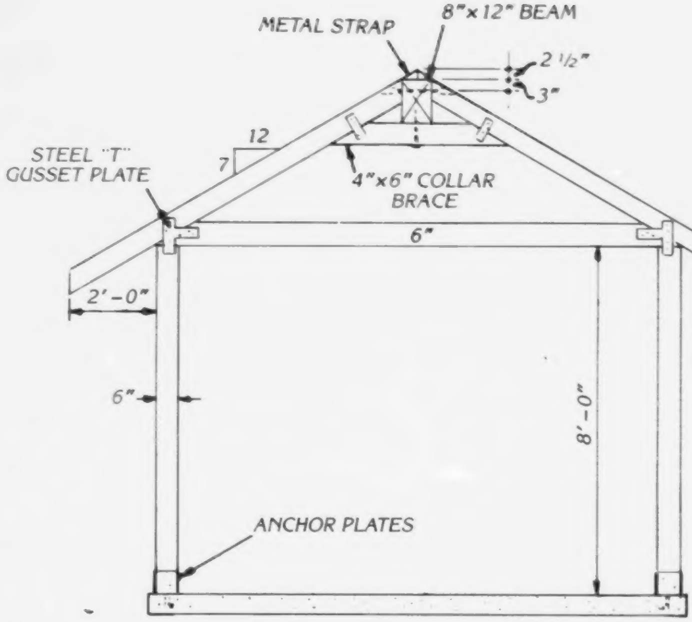

3"
12"
6"
1'-9"
6"
1'-2"
12'-0"
6'-4"
6"
5"
5'-9"
6'-0"
5'-9"
5"
22'-0"

SIDE ELEVATION

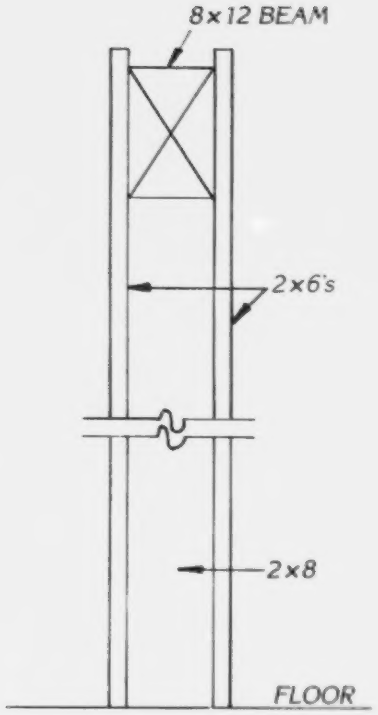
STRUCTURAL TIMBER PICNIC SHELTER

(SHEET #1)

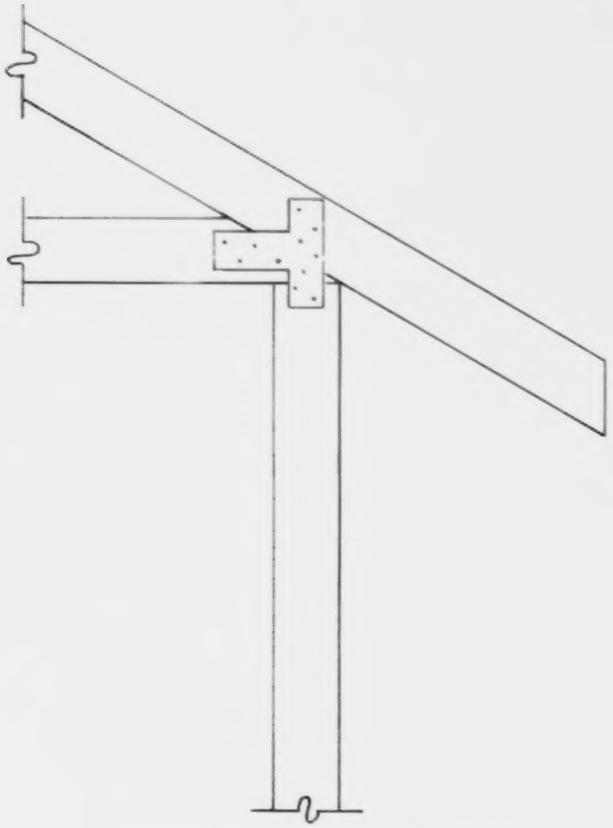
SCALE: 1/4" = 1'


METAL STRAP
8"×12" BEAM
2 1/2"
3"
12
7
STEEL "T" GUSSET PLATE
4"×6" COLLAR BRACE
6"
2'-0"
6"
8'-0"
ANCHOR PLATES

END ELEVATION


8×12 BEAM
2×6's
2×8
FLOOR

TYPICAL SADDLE CONSTRUCTION

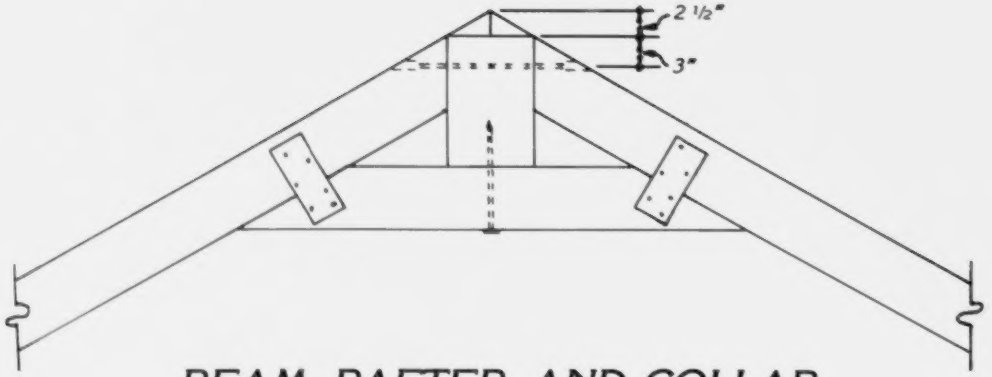


STEEL "T" GUSSET PLATE INSTALLATION

STRUCTURAL TIMBER PICNIC SHELTER

(SHEET #2—DETAILS)

SCALE: 3/4" = 1'



BEAM, RAFTER, AND COLLAR BRACE CONSTRUCTION

3. Plumb and brace saddles

K. Raise ridge beam and place in saddles

(NOTE: If there is a crown in the beam be sure it is turned up.)

1. Place with two foot marks on ends of beam flush with outside edge of end joists

2. Plumb, level, and brace beam

3. Place a saddle near center of beam, making sure that it will not be in the way when rafters are installed

L. Install rafters

1. Measure and cut rafters to length, allowing for two-foot projections

2. Plumb a line from one side of joist up to ridge beam and mark

(NOTE: This will place rafter over the joist in the correct position.)

3. Raise rafters in place and nail temporarily

4. Position a gusset plate as shown on plan and mark hole locations on post, joists, and rafters

5. Drill holes in post, joists, and rafters with proper size wood bit

6. Use lag screws to securely attach gusset plates to post, joists, and rafters

7. Continue setting rafters and gusset plates until all are installed

8. Mark locations of holes for allthread rod where they go through rafters and beam

9. Use proper size wood bit to drill holes for allthread rod

10. Countersink holes for allthread rod

11. Place a washer and nut on one end of allthread rods and insert into drilled holes

12. Place a washer and nut on opposite end of rod and tighten nuts securely

(NOTE: Be sure top of rafter is flush with top of ridge beam)

13. Continue marking, drilling holes, and installing allthread rods until rafters are all secured

M. Install collar braces

1. Measure and cut collar braces to length

2. Determine correct angle of cut for ends of collar braces

JOB SHEET #1

3. Measure, mark, and cut collar braces

   (NOTE: Be sure angle on collar braces matches pitch of roof and braces fit tightly under ridge beam.)

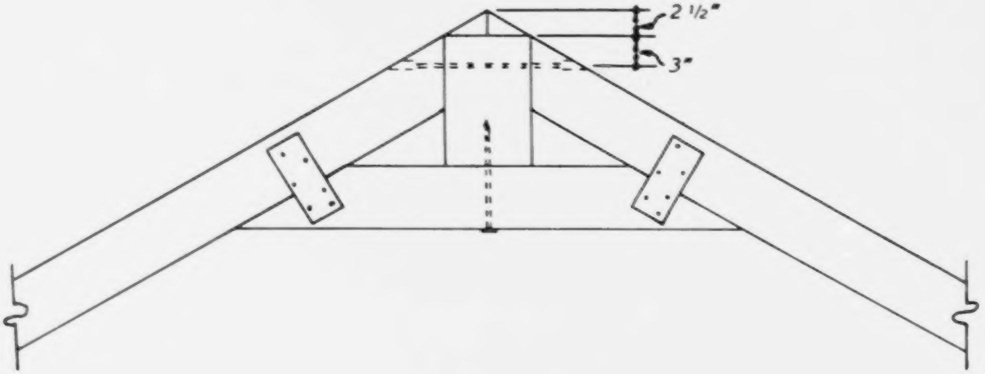
4. Hold gusset plate in proper location and mark hole locations on rafters and collar braces

5. Drill holes in rafters and collar braces with proper size wood bit

6. Use lag screws to securely attach gusset plates to rafters and collar braces

7. Continue setting collar braces until all are installed and all gusset plates are bolted securely in place (Figure 24)

FIGURE 24



JOB SHEET #1

8. Locate exact center of beam and drill a hole through collar brace into beam bottom with proper size wood bit

9. Insert lag screw through collar beam into beam bottom and tighten securely

N. Nail chamfered filler strips on top of ridge beam

O. Drill holes and install metal straps over chamfer strips into rafters

P. Remove temporary bracing

Q. Clean work area and put away tools and equipment when the project work is completed

(NOTE: The structure may be finished if it is to be permanent with roofing, etc. or it may be disassembled.)

STRUCTURAL TIMBER CONSTRUCTION
UNIT V

TEST

NAME ________________________________ SCORE ______________

1. Match the terms on the right to the correct definitions by placing the appropriate numbers in the blanks provided.

_____a. Round steel plate used primarily for connecting wood to nonwood

_____b. Type of construction whose structural system is composed of solid stock or glue-laminated timbers which offer a significant degree of fire resistance by limiting the minimum cross-sectional dimension of members and decking

_____c. Mechanical means of connecting timbers to each other or to a fixed object

_____d. Timber or glue-laminated member used in a horizontal position to transfer floor or roof loads to columns

_____e. Timbers or glue-laminated members used in vertical position to support beams

_____f. Steel ring with a tongue and groove split in the band

_____g. Any lumber generally 2" or thicker laid as the floor or roof of a structure

_____h. Horizontal timbers supporting the common rafters in a roof

_____i. To make by uniting superimposed layers of one or more materials

_____j. Engineered, stress rated product of wood laminations securely bonded together with adhesives

1. Wood column
2. Wood beam
3. Glue-laminated beam
4. Connection
5. Split ring
6. Shear plate
7. Heavy timber construction
8. Laminate
9. Purlin
10. Decking

2. List three types of buildings in which structural timber construction is used.

a. ________________________________

b. ________________________________

c. ________________________________

TEST

3. Identify the basic components used in structural timber construction from the illustration below by placing the correct numbers in the blanks provided.

_____a. Column

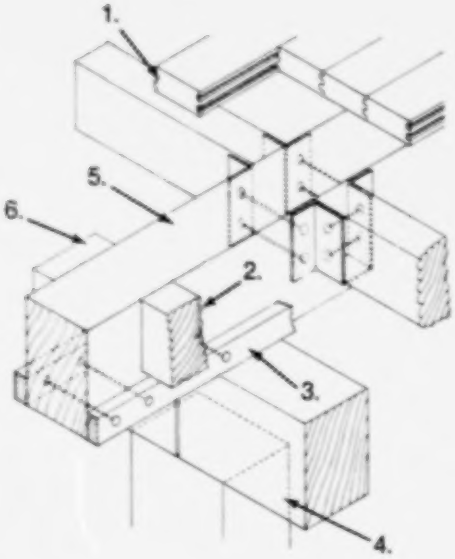
_____b. Beam

_____c. Decking

_____d. Ledger

_____e. Girder

_____f. Purlin



4. List two factors that have contributed to the more efficient use of structural timber in modern construction.

a. ____________________

____

b. ____________________

____

5. List two factors that determine the size of the components in structural timber construction.

a. ____________________

b. ____________________

TEST

6. Identify the connecting devices in the illustration below that are used with structural timbers by placing the correct numbers in the blanks provided.

_____a. Metal angle with bolts

_____b. Malleable iron shear plate

_____c. Wood splice plate
(with bolts and washers)

_____d. Metal splice plate
(with bolts)

_____e. Metal shoe connection

_____f. Metal hanger

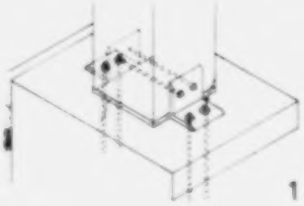
_____g. Metal strap and shear
plate connection

_____h. Lateral tie

_____i. Column cap

_____j. Split ring

_____k. Bearing plate and anchor bolts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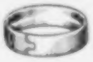
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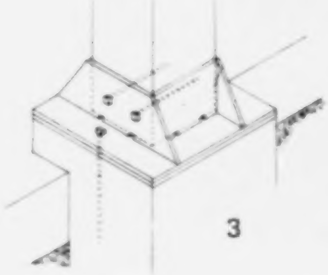
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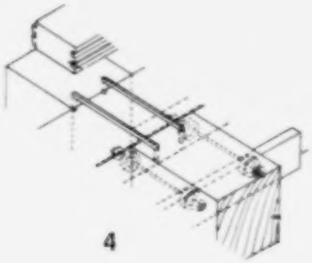
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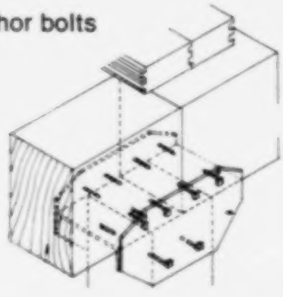
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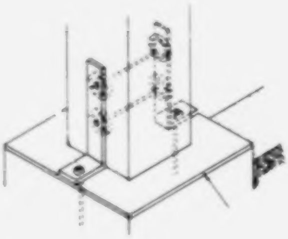
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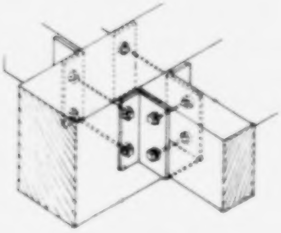
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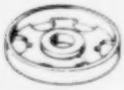
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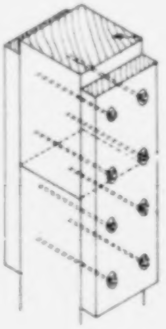
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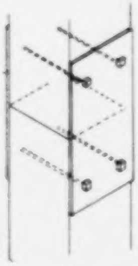

10

TEST

7. Identify the hardware items in the illustrations below that are used in structural timber construction by placing the correct numbers in the blanks provided.

______a. Anchor bolt

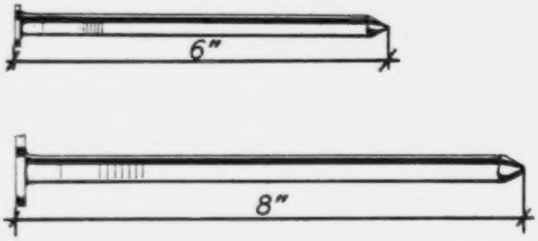
______b. Lag screw

______c. Machine bolt

______d. Washers

______e. Spikes

1



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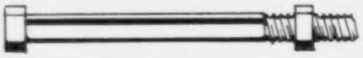

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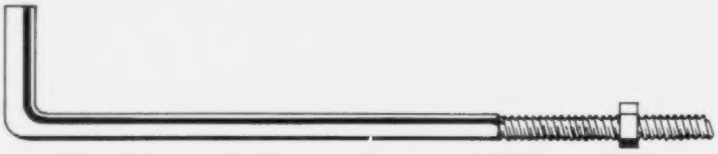

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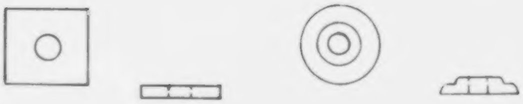

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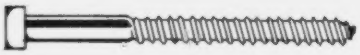


TEST

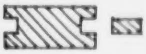
8. Identify the types of decking illustrated below by placing the correct numbers in the blanks provided.

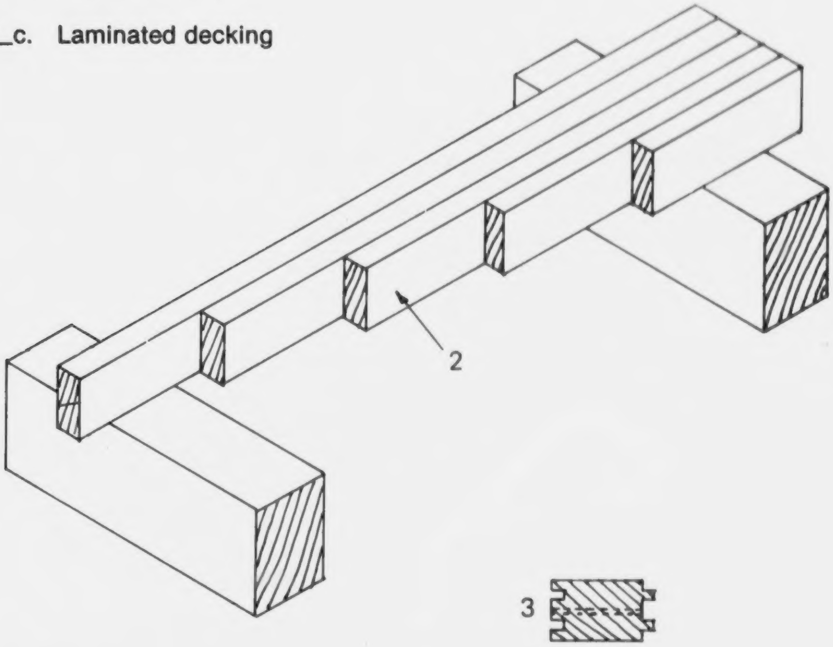
_____a. Tongue and groove

_____b. Grooved for spline

_____c. Laminated decking

1





3

(NOTE: Test question 9 lists the job sheet. It is an important part of this test. If it has not been completed, check with your instructor.)

9. Demonstrate the ability to construct a structural timber picnic shelter.

STRUCTURAL TIMBER CONSTRUCTION
UNIT V

ANSWERS TO TEST

1. a. 6
   b. 7
   c. 4
   d. 2
   e. 1
   f. 5
   g. 10
   h. 9
   i. 8
   j. 3

2. Answer should include any three of the following

   a. Industrial
   b. Commercial
   c. Institutional
   d. Recreational
   e. Residential

3. a. 4
   b. 5
   c. 1
   d. 3
   e. 6
   f. 2

4. Answer should include any two of the following

   a. Development and refinement of stress-graded timber, both solid and glue-laminated
   b. Production of modern types of timber construction
   c. Full recognition of fire resistance of large timber sections
   d. Use of preservatives to help timber withstand the deteriorating effects of moisture, disease, and insects

5. Answer should include any two of the following

   a. Load
   b. Span of girders, beams, and decking
   c. Unsupported height of columns
   d. Grade and species of timber

6. a. 1
   b. 8
   c. 9
   d. 10
   e. 3
   f. 7
   g. 6
   h. 4
   i. 5
   j. 2
   k. 11

ANSWERS TO TEST

7.
   - a. 3
   - b. 5
   - c. 2
   - d. 4
   - e. 1

8.
   - a. 3
   - b. 1
   - c. 2

9. Performance skills evaluated to the satisfaction of the instructor.

FIREPROOF METAL STUD CONSTRUCTION

UNIT VI

UNIT OBJECTIVE

After completing this unit, the student should be able to layout walls and door jambs and should be able to install stud walls and door jambs using fireproof metal studs. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with fireproof metal stud construction to their correct definitions.
2. Name components of metal stud systems.
3. Identify fasteners used for metal stud construction.
4. Identify tools and equipment used in metal stud construction.
5. List where metal stud systems are used.
6. Select from a list advantages of metal stud systems.
7. List methods used to install fixture supports on metal stud systems.
8. Demonstrate ability to
    a. Lay out wall lines, corners, partitions, and openings.
    b. Install a metal stud wall.
    c. Install a metal door frame.
    d. Install a knockdown-type metal door frame.

FIREPROOF METAL STUD CONSTRUCTION
UNIT VI

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency masters

    1. TM #1 — Components of a Metal Stud System

    2. TM #2 — Components of a Metal Stud System (Continued)

  D. Information sheet

  E. Job sheets

    1. Job Sheet #1 — Lay Out Wall Lines, Corners, Partitions, and Openings

    2. Job Sheet #2 — Install a Metal Stud Wall

    3. Job Sheet #3 — Install a Metal Door Frame

    4. Job Sheet #4 — Install a Knockdown-Type Metal Door Frame

  F. Test

  G. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain materials necessary to supplement unit.

    1. Obtain transparencies and competency profiles.

       (NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W., Washington, DC 20006, phone 202-393-2040.)

    2. A good source of information is "Gypsum Construction Handbook" from United States Gypsum, 101 South Wacker Drive, Chicago, Illinois 60606.

SUGGESTED ACTIVITIES

C. Introduce unit.

SUGGESTIONS:

- Discuss metal stud framing and the skills required; review fundamentals according to the needs of your class.
- Provide the class with articles, brochures, and photos of buildings using fireproof metal stud systems.

  (NOTE: "Gypsum Construction Handbook" can provide specifications and technical data for materials used in fireproof metal stud systems.)

D. Provide students with objective sheet.

E. Discuss objective sheet, relating the objectives to commercial carpentry and to your introduction.

F. Provide students with information sheet.

G. Discuss information sheet.

1. Use Information Sheet, Section I to discuss terms associated with fireproof metal stud construction.

   SUGGESTIONS:

   - Show students samples of listed materials whenever possible.

     EXAMPLE: Metal studs, runners, furring channels, fasteners

   - Relate terms to the objectives, such as making connections between the terms for tools and the objectives on tools.

2. Use Information Sheet, Section II and Transparencies 1 and 2 to discuss components of metal stud systems.

   SUGGESTIONS:

   - Show actual samples of the different components used in metal stud systems.
   - Make a model of a wall using the different components.
   - Emphasize the function of each part and the importance of connecting these parts together properly.
   - Show the students how flimsy the framework is and how sturdy it becomes when the wall finish is attached to it.

SUGGESTED ACTIVITIES

- Explain the different metal gauges that are used for the construction of these components, and the various widths and lengths available.
- Explain to the students which components may be safely used for non-load bearing walls and which for load bearing walls.
- Explain the various styles and color coding used to help identify them.
- Explain to the students the need of safety precautions when working with metal stud systems, especially the sharp edges on the metal.

3. Use Information Sheet, Section III to discuss fasteners used in metal stud construction.

SUGGESTIONS:

- Show students samples of all the different types and sizes of fasteners.

  EXAMPLES: Bugle head screws, trim head screws, oval head screws, pan head screws, hex washer head screws, masonry nails, screw anchors

- Explain where and why the different fasteners are used.

  EXAMPLE: 1" bugle head screws are used to apply 1/2" drywall to metal studs, runners and channels 1 1/4"; oval head screws are used to mount wood cabinets through single layer drywall to metal studs; 1" and 1 5/8" trim head screws are used to install wood trim over single layer panels to metal studs and runners

- Explain the importance of using the correct fastener for the job being done.
- Explain the holding power of one screw over another or over nails and how some fasteners such as nails may pop out in some types of construction.
- Explain why fewer screws than nails are required and the speed of installation when using screws.
- Explain how the drill point, self-drilling, self-tapping, and the threads on the screws minimize stripping and provide maximum holding power.
- Also explain how important it is to use the correct fastener and size of fastener for the job, especially for fire-related construction; how nails or screws used on wood frames close to the surface get hot enough to actually char the wood, which will reduce their holding power.

SUGGESTED ACTIVITIES

4. Use Information Sheet, Section IV to discuss tools and equipment used in metal stud construction.

   SUGGESTIONS:

   - Refer back to units I, II, and III, Section C in *Fundamentals of Carpentry* and review the guidelines for care and safe use of tools, safety rules pertaining to power tools, and safety precautions pertaining to miscellaneous equipment.
   - Also review safety and basic first aid.
   - Show film "Safety in the Shop: Hand Tools" and other safety films that are available.
   - Demonstrate how to clean and store tools properly.
   - Explain how quantity and quality of work increases when tools are in proper condition.
   - Display each of the hand tools listed in this section.
   - Caution students against using tools for a job which they were not designed for.
   - Demonstrate proper use of each tool.
   - Demonstrate the procedure for setting up a builder's level, and point out correct handling of the level and storage case.
   - Have students review Unit I, Section D, "Builder's Level and Transit" in *Fundamentals of Carpentry*.
   - Arrange for a field trip to a job site where metal stud systems are being constructed. Have students pay attention to the use of the various tools being used (only if they are being used properly).

5. Use Information Sheet, Sections V, VI, and VII to discuss where metal stud systems are used, the advantages of this system and the types of fixture supports.

   - Plan a field trip to a construction site where metal stud systems are being constructed. Point out to the students the various areas where metal stud systems are used and relate them to the information in these sections.
   - Explain the advantages of using metal stud systems.

SUGGESTED ACTIVITIES

- Have the students explain the relationship of the advantages of this system to the areas where it is being used.
- While on the field trip, have the students point out where fixture supports are used, how they relate to the information in Section VII, how many different types of supports match the types in the information sheet and if there are any other types being used.
- Have each student pick out one of the types of fixture supports and demonstrate procedures for installing this particular support.

6. Demonstrate procedures in job sheets; allow students to practice the procedure at training facility.

SUGGESTIONS:

- Pair off students and let them practice procedures then switch them so each will do different jobs.
- Take students to job site and have them practice procedures for the different job sheets, starting with layout.
- Praise students when they do a good job. Encourage and support students that need it.

H. Review unit.

I. Give test.

J. Critique and discuss test in class.

K. Reteach and retest as required.

L. Complete appropriate sections of competency profiles.

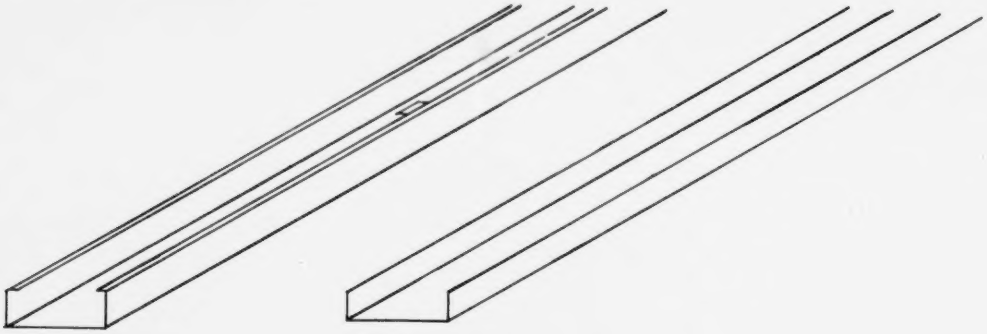
III. Unit references

A. *Hollow Metal Doors and Frames*. Mason City, Iowa: Curries Mfg. Inc./Subsidiary of Kidde Inc., 1985.

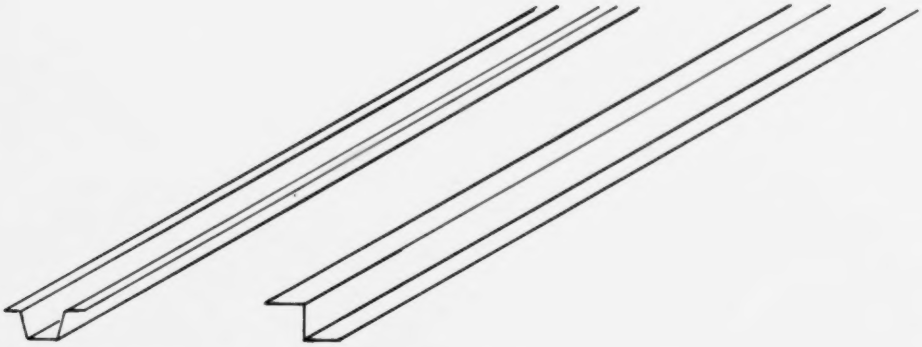
B. *Gypsum Construction Handbook* with Product and Construction Standards. 2nd ed. Chicago, Illinois: United States Gypsum, 1982.

C. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

Components of a Metal Stud System

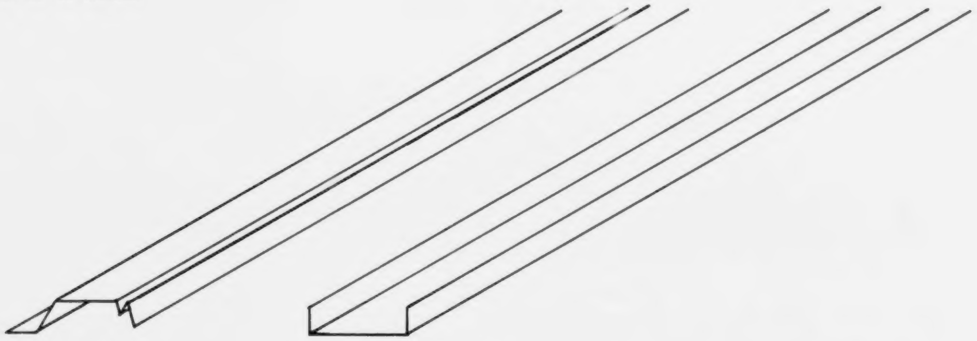


STUD CH. RUNNER



METAL FURRING CHANNEL

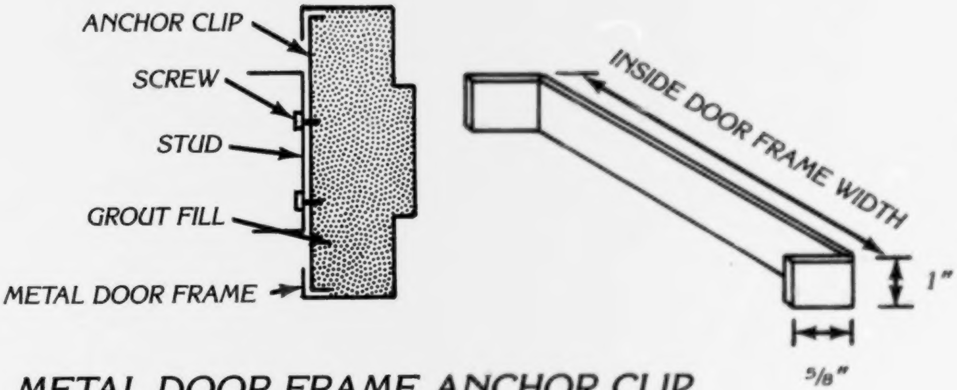
Z-FURRING CHANNEL



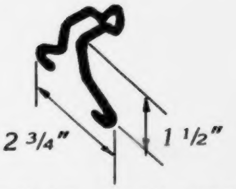
RESILIENT CHANNEL

C-CHANNEL (COLD-ROLLED)

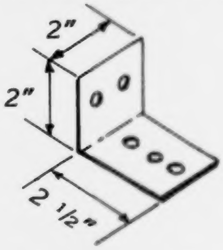
Components of a Metal Stud System
(Continued)


ANCHOR CLIP
SCREW
STUD
GROUT FILL
METAL DOOR FRAME
INSIDE DOOR FRAME WIDTH
1"
5/8"

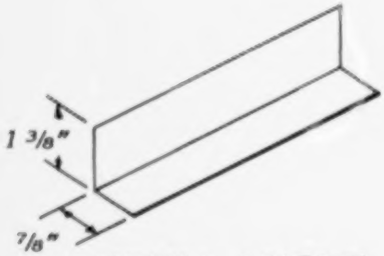
METAL DOOR FRAME ANCHOR CLIP



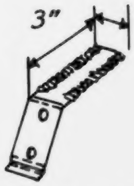
FURRING CHANNEL CLIP



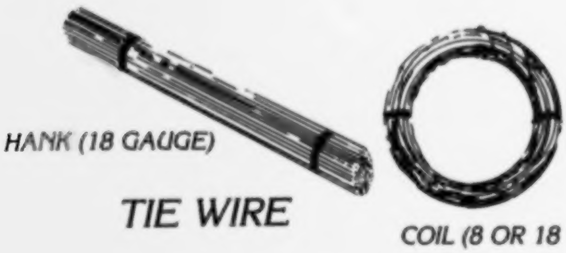
BREAKAWAY CLIP



METAL ANGLE



FURRING BRACKET ADJUSTABLE WALL


HANK (18 GAUGE)
COIL (8 OR 18 GAUGE)

TIE WIRE

FIREPROOF METAL STUD CONSTRUCTION
UNIT VI

INFORMATION SHEET

I. Terms and definitions

A. Fireproof metal stud construction — Method of construction in which the properties or materials of a structure resist the effects of fire

B. Runner — Metal channel used to anchor the studs at floor and ceiling

C. Stud crimper — Hand tool used to attach studs to runners by crimping

D. Magnetic punch (nail holder) — Tool with one end magnetized to hold short masonry nails while they are being driven

E. Curtain wall — A non-bearing wall built between piers or metal columns; a wall acting merely as a screen to hide something

F. Fixture supports — Blocking or supports attached between studs to form a solid support for anchoring fixtures such as sinks, toilets, and cabinets to the walls

G. Breakaway clip — An aluminum angle used to attach area walls to floor and roof framing, designed to melt and break away when exposed to fire

H. Channel-stud shear — Hand-operated tool used to cut runners and studs on the job

I. Door frame jack — Device used to hold door frame in position while setting the frame

II. Components of metal stud systems

(NOTE: All components are made from non-combustible, corrosion-resistant steel.)

A. Stud

B. Runner

C. Metal furring channel

D. Z-furring channel

E. Resilient channel

F. C-channel (cold-rolled)

G. Furring channel clip

INFORMATION SHEET

H. Door jamb anchor clip

I. Metal angle

J. Adjustable wall framing bracket

K. Breakaway clip

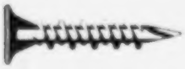
L. Tie wire

III. Fasteners used for metal stud (Figures 1-27)

A. Screws

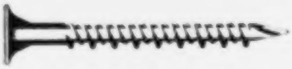
1. Bugle head, type S, 1" to 1 1/4"

FIGURE 1



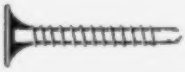
2. Bugle head, type S, 1 5/8" to 3"

FIGURE 2



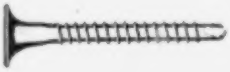
3. Bugle head, type S-12, 1"

FIGURE 3



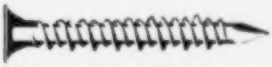
4. Bugle head, type S-12, 1 1/4"to 3"

FIGURE 4



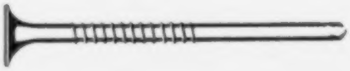
5. Bugle head, type G, 1 1/2"

FIGURE 5



6. Bugle head, pilot point, type S-12, 1 15/16"

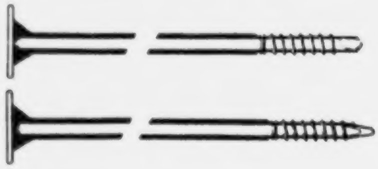
FIGURE 6



INFORMATION SHEET

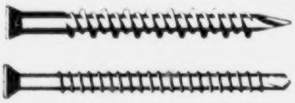
7. Wafer head, type S-12 or R, 1 1/2" to 3"

FIGURE 7



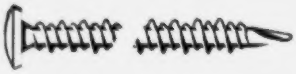
8. Trim head, type S or S-12, 1" to 2 1/4"

FIGURE 8



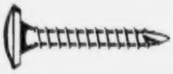
9. Oval head, type S, 1 1/4" to 3 3/4"

FIGURE 9



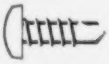
10. Oval head, type S-18 cadium plated, 7/8"

FIGURE 10



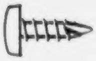
11. Pan head, type S, 3/8"

FIGURE 11



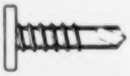
12. Pan head, type S-12, 3/8" and 1/2"

FIGURE 12



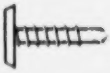
13. Low profile head, type S-12, 5/8"

FIGURE 13



14. Pancake head, type S-12, 3/8" and 1/2"

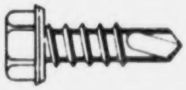
FIGURE 14



INFORMATION SHEET

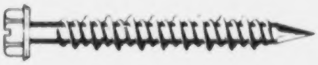
15. Hex washer head cadium plated, type S-4, 3/4"

FIGURE 15



16. Acorn slotted tapcon anchor 3/16" × 1 3/4"

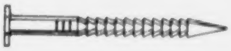
FIGURE 16



B. Nails

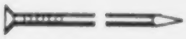
1. Annular ring drywall

FIGURE 17



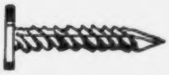
2. Color nails (for vinyl panels)

FIGURE 18



3. Masonry

FIGURE 19

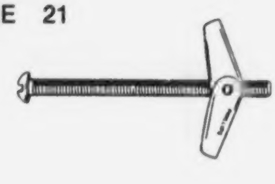


C. Powder-actuated fastener drive pin

FIGURE 20

D. Toggle bolt

FIGURE 21

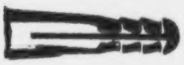


INFORMATION SHEET

E. Screw anchors

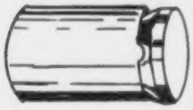
1. Plastic screw anchor

FIGURE 22



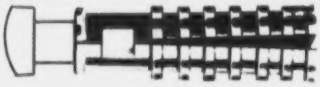
2. Caulking anchor

FIGURE 23



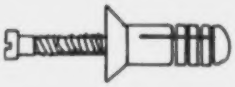
3. Lead screw anchor

FIGURE 24



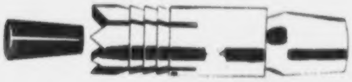
4. Nylon anchor

FIGURE 25



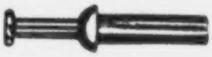
5. Self-drilling anchor

FIGURE 26



6. Nail drive type

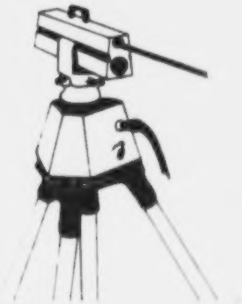
FIGURE 27



IV. Special tools and equipment used in metal stud construction (Figures 28-45)

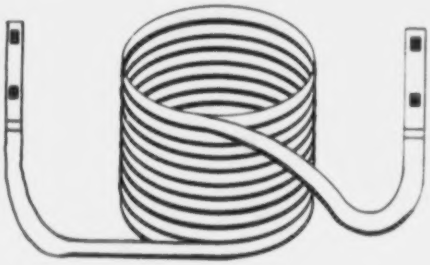
A. Laser-beam level

FIGURE 28



B. Water level

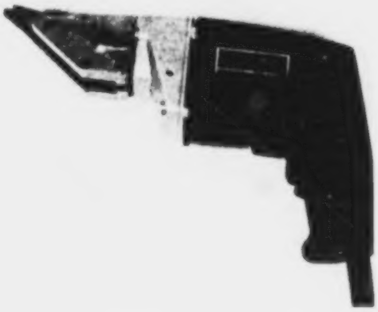
FIGURE 29



INFORMATION SHEET

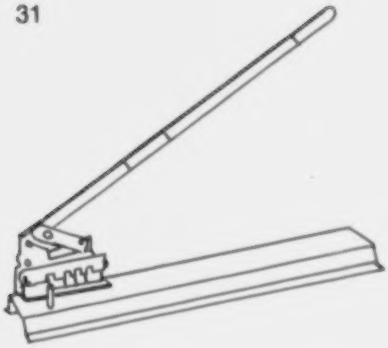
C. Power hand shear

FIGURE 30



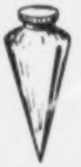
D. Channel-stud shear

FIGURE 31



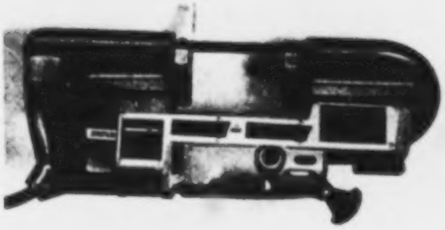
E. Plumb bob

FIGURE 32



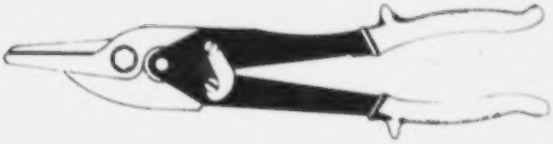
F. Band saw

FIGURE 33



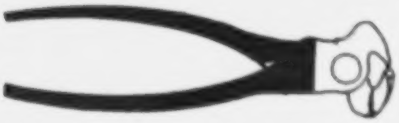
G. Metal snips

FIGURE 34



H. End cut nippers

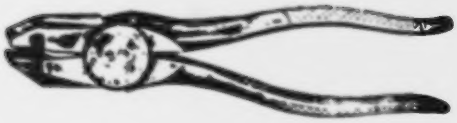
FIGURE 35



INFORMATION SHEET

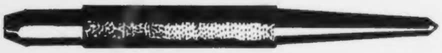
I. Side cut pliers

FIGURE 36



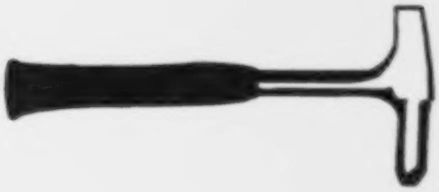
J. Center punch

FIGURE 37



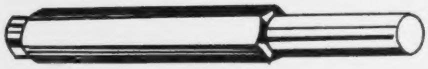
K. Magnetic hammer

FIGURE 38



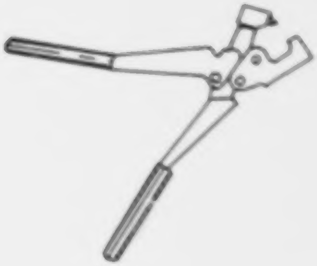
L. Magnetic punch (nail holder)

FIGURE 39



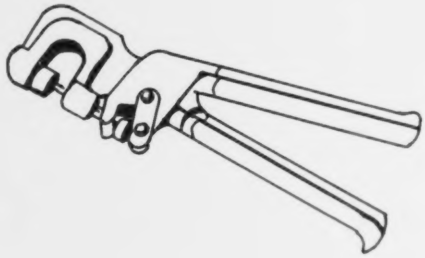
M. Stud crimper (lock fastener)

FIGURE 40



N. Metal punch

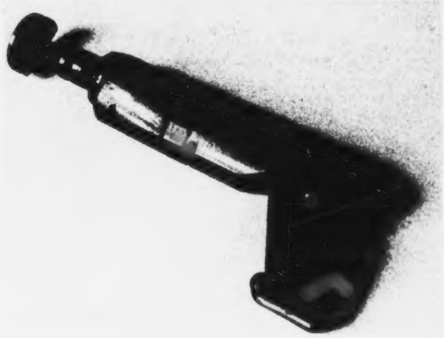
FIGURE 41



INFORMATION SHEET

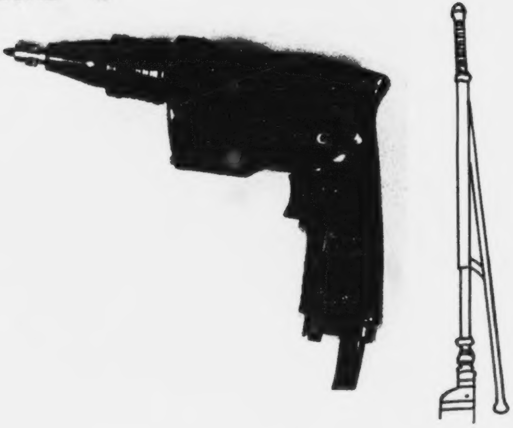
O. Powder-actuated fastener

FIGURE 42



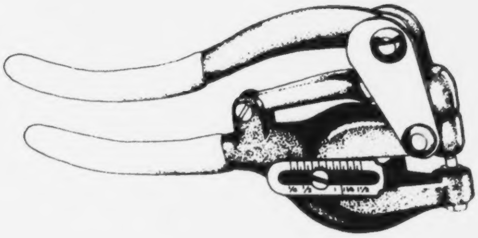
P. Power screw gun and adapter

FIGURE 43



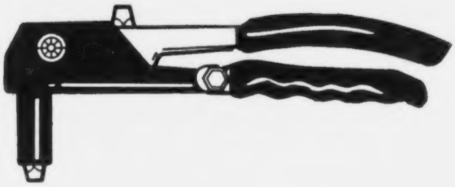
Q. Hand punch

FIGURE 44



R. Pop riveter

FIGURE 45



V. Areas where metal stud systems are used

- A. Area separation walls (between units in multifamily buildings)
- B. Shaft walls around elevators
- C. Mechanical shafts
- D. Return air ducts
- E. Stair wells
- F. Smoke shafts
- G. Interior partition walls

INFORMATION SHEET

- H. Column and pilaster fireproofing
- I. Ceilings
- J. Curtain wall assemblies
- K. Mansard roof framing
- L. Soffit framing
- M. Canopies

VI. Advantages of metal stud systems

- A. Light weight
- B. Low cost
- C. Fast installation
- D. Durability
- E. Fire resistance
- F. Sound control values
- G. Versatility in meeting job requirements

VII. Types of fixture supports

(NOTE: To insure satisfactory job performance it is important to understand the particular fixture attachment so that sound-control characteristics will be maintained and attachment will meet the load-carrying capacity.)

- A. Sheet metal screw attached to 25 gauge minimum sheet metal plate or strip, laminated between face board and base board in laminated drywall partitions
- B. Sheet metal screws driven through drywall into steel studs (lightweight fixtures)
- C. Notched runner attached to steel studs with pan head screws
- D. Bolt welded to nested 1 1/2" channels for mounting hanger brackets for heavy fixtures
- E. Molly bolts installed in drywall (lightweight fixtures)
- F. Toggle bolts installed in drywall (lightweight fixtures)

INFORMATION SHEET

G. Bolt welded to 1 1/2" channel and inserted in notches cut in stud for mounting hanger brackets for heavy fixtures

H. Slotted shelf standards attached to studs or steel reinforcing (between drywall layers) with screws

I. Channels (which are installed horizontally to studs then covered with drywall installed horizontally) attached with 2 1/4" screws between studs for cabinets

FIREPROOF METAL STUD CONSTRUCTION
UNIT VI

JOB SHEET #1 — LAY OUT WALL LINES, CORNERS, PARTITIONS, AND OPENINGS

I. Tools and equipment

   A. Chalk line

   B. 100-foot tape

   C. Folding rule or steel tape

   D. Floor plan

   E. Masonry

   F. Can of spray paint (red or yellow)

II. Procedure

   A. Lay out exterior walls (Figure 46)

      1. Measure from the outside face of the total wall thickness at two corners on one side of the building

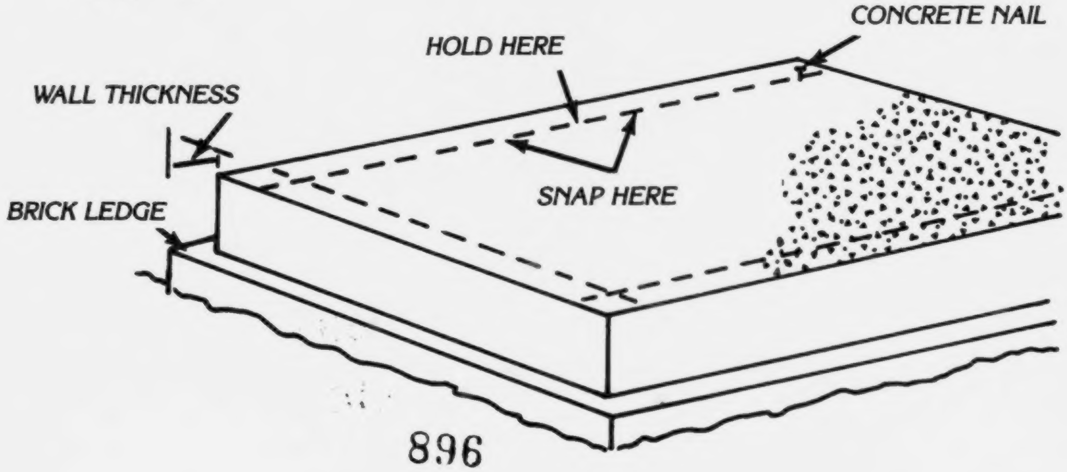
      2. Drive a short masonry nail on one of the marks

      3. Hook looped end of chalk line on nail

      4. Pull chalk line tight over mark on other end and snap

      (NOTE: When snapping long lines, it is advisable to snap from the middle of the line by holding the line tight to the floor with one hand snapping the two halves separately.)

FIGURE 46

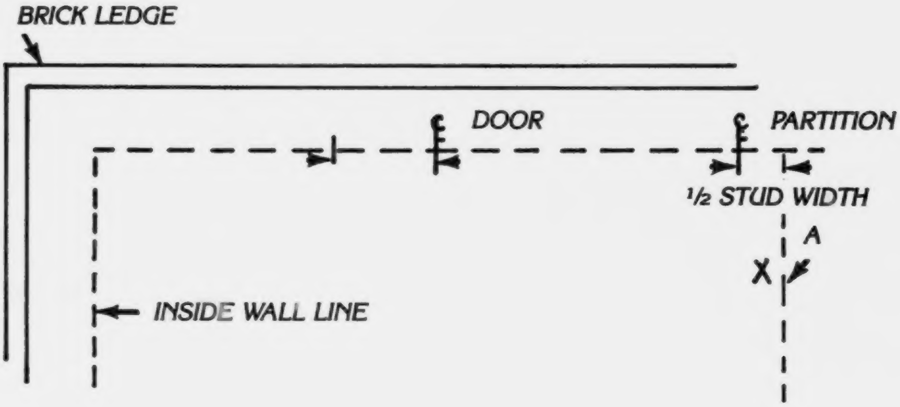


JOB SHEET #1

B. Lay out inside walls and doors (Figure 47)

1. Hold loop end of measuring tape on inside wall line and mark centerlines of all doors and partitions

FIGURE 47



2. Repeat step 1 on opposite side of the building
3. Measure over one-half the thickness of the stud from the partition centerline on both ends of the partition
4. Snap a chalk line between these points
5. Mark partition side of line with an X
6. Lay out all partitions following steps 1 through 5
7. Lay out centerlines of all openings and partitions
8. Measure one-half the width of the metal door frame on each side of the door centerlines

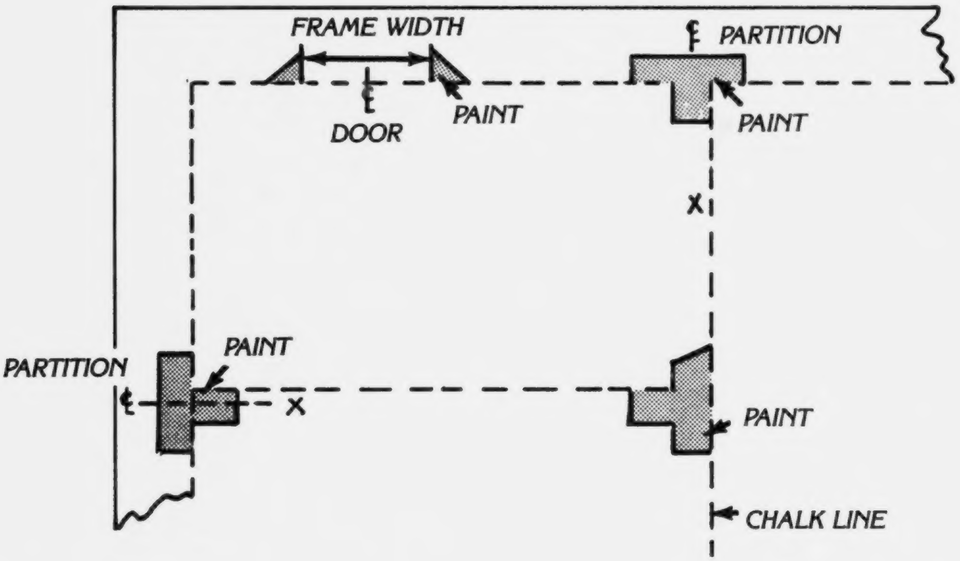
   (NOTE: Check from corner to door frame and adjust for modular units.)

JOB SHEET #1

9. Paint partition intersections and door frame sides (Figure 48)

   (NOTE: Lay thin boards on floor at layout lines and spray paint floor.)

FIGURE 48


FRAME WIDTH
℄ DOOR
PAINT
℄ PARTITION
PAINT
X
PARTITION ℄
PAINT
X
PAINT
CHALK LINE

C. Continue installation or clean work area and put away tools and materials

FIREPROOF METAL STUD CONSTRUCTION
UNIT VI

JOB SHEET #2 — INSTALL A METAL STUD WALL

(NOTE: Layout and frame setting have been outlined in Job Sheet #1.)

I. Tools and equipment

- A. Folding rule or steel tape
- B. Hand level
- C. Claw hammer
- D. Magnetic nail holder
- E. Stud shear
- F. Crimping tool
- G. Plumb bob
- H. Chalk line
- I. Metal snips
- J. Powder-actuated fastener and pins

> **CAUTION**
> Be sure you have a "Qualified Operators Card" and follow safety guidelines pertaining to powder-actuated fasteners.

- K. Studs
- L. Runners
- M. Metal door frame anchors
- N. Nails, ½" masonry
- O. ⅜", ½" type S or S-12 pan head screws
- P. Floor plan

II. Procedure

- A. Install runners
  - 1. Secure runners to floor with powder actuated fastener

    (NOTE: Use ½" masonry nails and magnetic driver in corners and places hard to get to.)

JOB SHEET #2

2. Plumb up from floor runner to locate ceiling runner

   (NOTE: Use plumb bob at ends of wall to establish marks on ceilings.)

3. Snap a chalk line between points

4. Check floor plan for stud spacing then lay out stud spacing on floor and ceiling runner

5. Secure ceiling runner to ceiling

   CAUTION
   Be sure stud layout is plumb over floor runner layout.

B. Install studs

1. Cut studs to length

   (NOTE: Studs may be purchased precut.)

2. Install full length studs

   a. Stand studs in position at layout marks

   b. Insert studs between runners, twisting them into position

      (NOTE: All full length studs should be positioned so that openings match horizontally and are all turned the same direction.)

   c. Anchor all studs to floor and ceiling runners with crimping tool or type S pan head screws

      (NOTE: All studs adjacent to door and window frames, partition intersections, and corners should be anchored to floor and ceiling runners with crimping tool or positive screw attached with 3/8" or 1/2" type S or S-12 pan head screws through each stud and runner flange. Where heavy or oversize doors are used additional studs or heavy-duty structural studs will have to be installed at the jambs.)

3. Install header

   a. Fabricate header sections from runners cut approximately 6" to 8" longer than rough opening

   b. Lay out opening size on runner from a centerline

   c. Cut standing flanges at each end on the layout marks and bend web to allow flanges to overlap adjacent studs

   d. Securely attach flanges to studs with crimping tool or screws

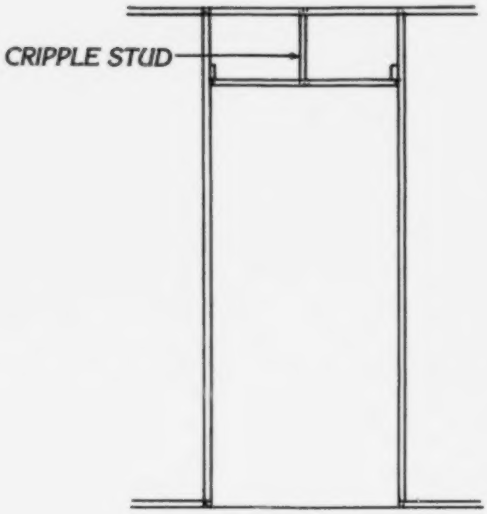
JOB SHEET #2

4. Install cripple studs

   a. Cut cripple studs to length

   b. Install cripple studs above and below openings spaced the same as regular studs and attach with crimping tool (Figure 49)

FIGURE 49



(NOTE: Where control joints in header boards are required install cripple studs ½" away from studs but do not attach cripples to runners or studs.)

C. Continue installation or clean work area and put away tools and materials

FIREPROOF METAL STUD CONSTRUCTION
UNIT VI

JOB SHEET #3 — INSTALL A METAL DOOR FRAME

I. Tools and equipment

  A. Folding rule or steel tape

  B. Hand level

  C. Powder-actuated fastener and drive pins

> **CAUTION**
>
> Follow safety guidelines pertaining to powder-actuated fasteners.

  D. Hammer

  E. Screwdriver and screws

  F. Floor plan

  G. Metal door frames

  H. Door frame jack

  I. Wood wedges and blocks

II. Procedures

  A. Check floor plans

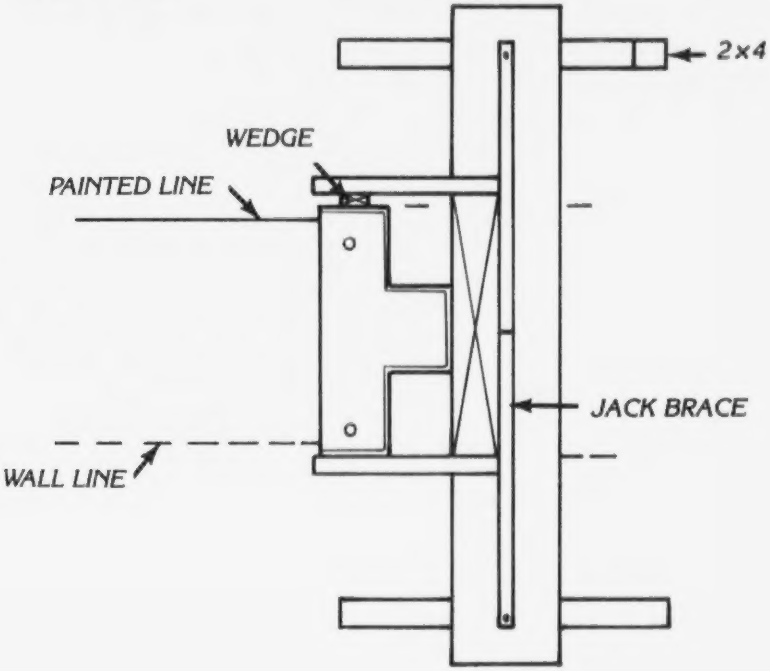
  B. Check layout on floor to be sure all lines are correct

  C. Stand frame upright at marks on floor

JOB SHEET #3

D. Place frame jack in position with ears on each side of frame (Figure 50)

FIGURE 50

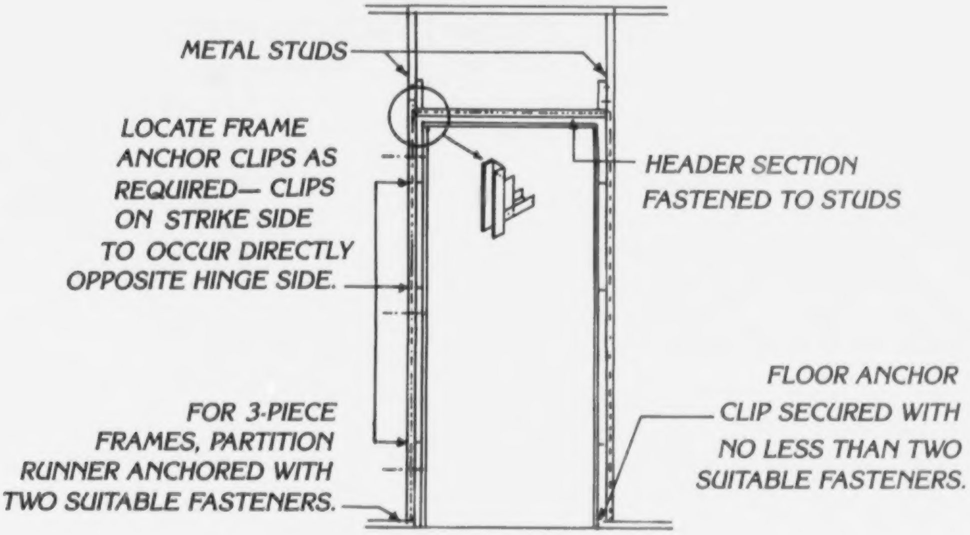

2×4
WEDGE
PAINTED LINE
JACK BRACE
WALL LINE

E. Place frame anchor clips in frame spaced approximately two feet on centers

JOB SHEET #3

F. Secure frame anchor clips to studs with $^{3}/_{8}$" type S-12 pan head screws (Figure 51)

FIGURE 51


METAL STUDS
LOCATE FRAME ANCHOR CLIPS AS REQUIRED— CLIPS ON STRIKE SIDE TO OCCUR DIRECTLY OPPOSITE HINGE SIDE.
HEADER SECTION FASTENED TO STUDS
FOR 3-PIECE FRAMES, PARTITION RUNNER ANCHORED WITH TWO SUITABLE FASTENERS.
FLOOR ANCHOR CLIP SECURED WITH NO LESS THAN TWO SUITABLE FASTENERS.

G. Anchor bottom of door frame

1. Line up frame in correct relationship to wall line
2. Use powder-actuated fastener to secure bottom anchor

CAUTION

Be sure you have a "Qualified Operators Card" and follow safety guidelines pertaining to powder-actuated fastener.

(NOTE: If top of frame is not level, place shim under anchor plate before securing.)

H. Insert wedges between ears on jack; align frame to plumb position

I. Continue installation or clean up work area and put away tools and materials

FIREPROOF METAL STUD CONSTRUCTION
UNIT VI

JOB SHEET #4 — INSTALL A KNOCKDOWN-TYPE METAL DOOR FRAME

I. Tools and equipment

   A. Folding rule or steel tape

   B. Hand level

   C. Framing square

   D. Screwdriver and screws

   E. Hammer

   F. Floor plan

   G. Metal door frame including corner clips

   H. Spacing bar

II. Procedures

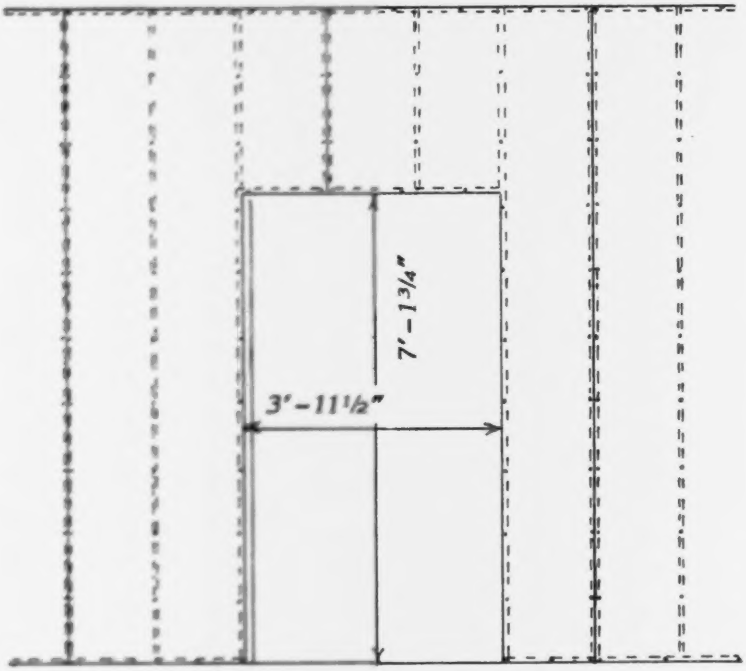
   A. Check floor plans

   B. Check layout on floor to be sure all lines are correct

JOB SHEET #4

C. Retract compression bars in the jamb and install one jamb in its proper position (Figure 52)

FIGURE 52

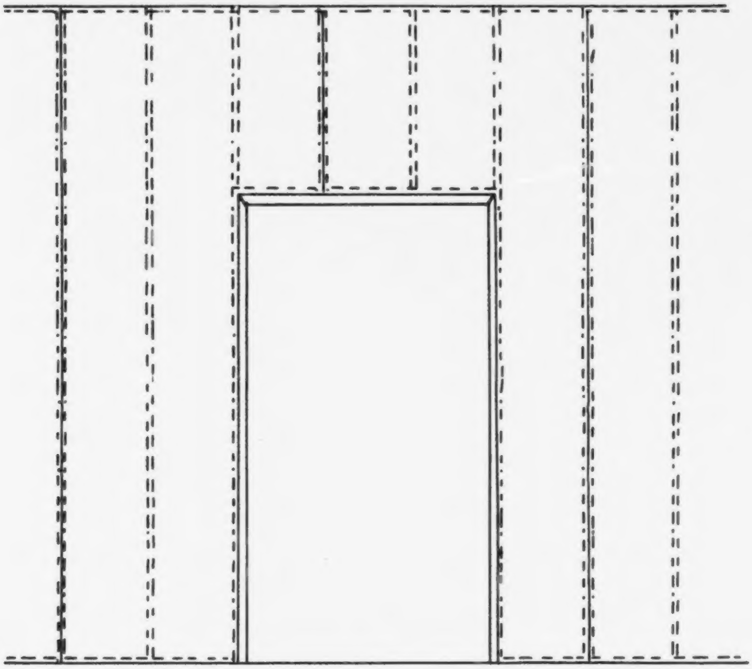


D. Insert frame head under the corner clips of the jamb and raise into position

JOB SHEET #4

E. Insert corner clips of the other side jamb into the opposite end of the head and move jamb in its proper position (Figure 53)

FIGURE 53



F. Locate frame spacing bar at base of frame to maintain proper opening width

G. Square and plumb frame

H. Install base anchor screws through holes in frame face and into floor plates

I. Square top of frame and tighten compression bars by turning screws counterclockwise

(NOTE: Do not overtighten screws.)

J. Install sheet metal screws at corners of the head jamb to anchor it to side jambs

K. Clean work area and put away tools and materials

FIREPROOF METAL STUD CONSTRUCTION
UNIT VI

TEST

NAME ________________________________ SCORE ______________

1. Match terms associated with fireproof metal stud construction to their correct definitions. Write the correct numbers in the blanks.

_____a. Blocking or supports attached between studs to form a solid support for anchoring fixtures such as sinks, toilets, and cabinets to the walls

_____b. Hand tool used to attach studs to runners by crimping

_____c. Tool with one end magnetized to hold short masonry nails while they are being driven

_____d. Hand operated tool used to cut runners and studs on the job

_____e. An aluminum angle used to attach area walls to floor and roof framing, designed to melt and break away when exposed to fire

_____f. Metal channel used to anchor the studs at floor and ceiling

_____g. Method of construction in which the properties or materials of a structure resist the effects of fire

_____h. A non-bearing wall built between piers or metal columns; a wall acting merely as a screen to hide something

_____i. Device used to hold door frame in position while setting the frame

1. Runner
2. Magnetic punch
3. Breakaway clip
4. Door frame jack
5. Curtain wall
6. Fixture support
7. Channel-stud shear
8. Fireproof metal stud construction
9. Stud crimper

2. Name eight components of metal stud systems.

a. ______________________________________

b. ______________________________________

c. ______________________________________

d. ______________________________________

TEST

e. ______________________________

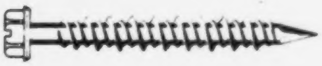
f. ______________________________

g. ______________________________

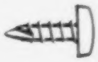
h. ______________________________

3. Identify illustrations of the following fasteners used for metal stud construction. Write the correct names in the blanks.

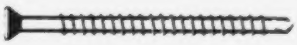
Acorn slotted tapcon anchor
Wafer head screw
Hex washer head screw
Nail drive anchor
Nylon anchor
Masonry nail
Annular ring drywall nail
Pancake head screw
Bugle head screw
Pan head screw
Platic screw anchor
Self-drilling anchor
Caulking anchor
Toggle bolt
Trim head screw
Oval head screw
Low-profile head screw
Color nail for vinyl panels
Drive pin
Lead screw anchor



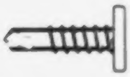
a. ______________________



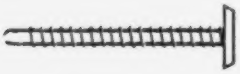
b. ______________________



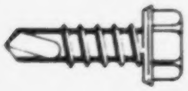
c. ______________________



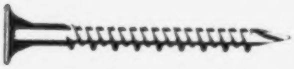
d. ______________________



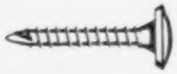
e. ______________________



f. ______________________

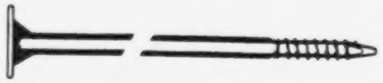


g. ______________________

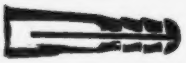


h. ______________________

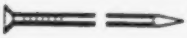
TEST



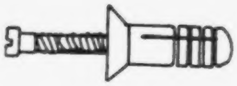
i. ______________________________



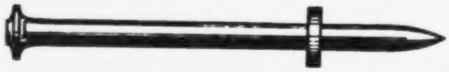
j. ______________________________



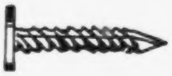
k. ______________________________



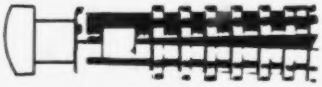
l. ______________________________



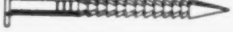
m. ______________________________



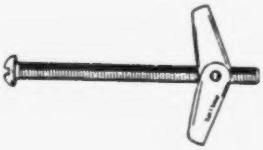
n. ______________________________



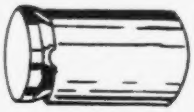
o. ______________________________



p. ______________________________

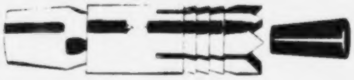


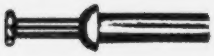
q. ______________________________



r. ______________________________

TEST

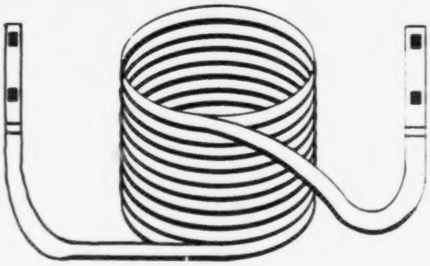


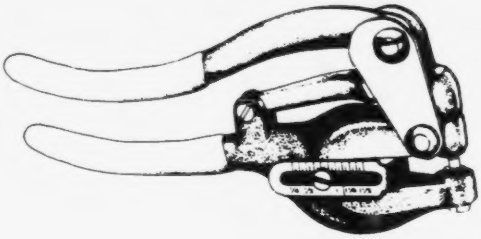


s. ______________________ t. ______________________

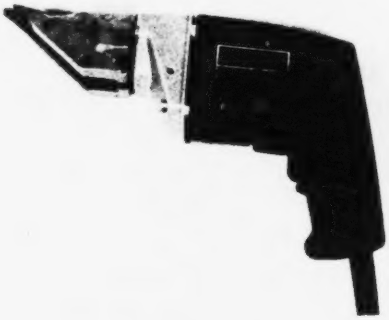
4. Identify illustrations of the following special tools and equipment used in metal stud construction. Write the correct names in the blanks.

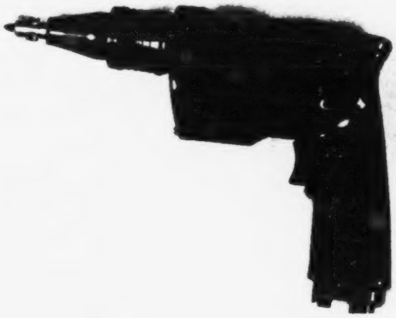
Band saw
Stud crimper
Screw gun adapter
Plumb bob
Side cut pliers
Powder-actuated fastener
Center punch
Laser-beam level
End cut nippers
Metal snips
Metal punch
Magnetic hammer
Magnetic punch
Water level
Channel-stud shear
Power hand shear
Power screw gun
Hand punch
Pop riveter





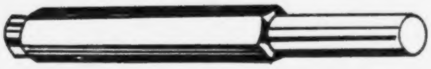
a. ______________________ b. ______________________



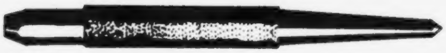


c. ______________________ d. ______________________

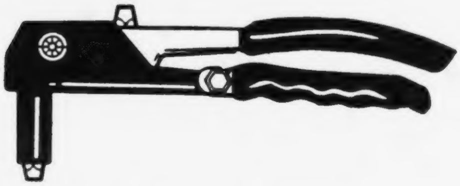
TEST



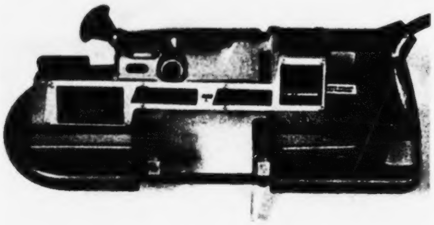
e. ______________________________



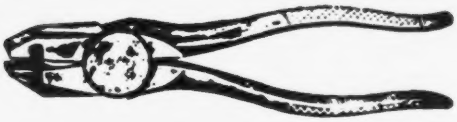
f. ______________________________



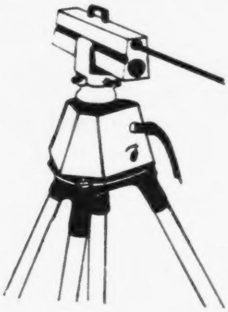
g. ______________________________



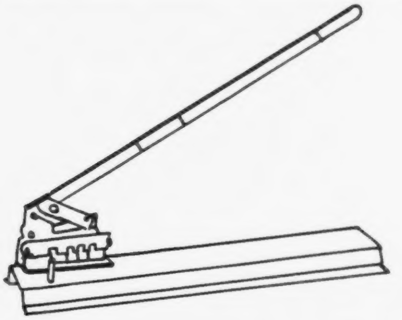
h. ______________________________



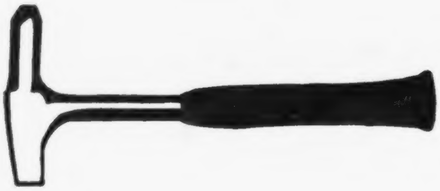
i. ______________________________



j. ______________________________

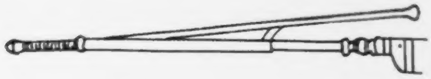


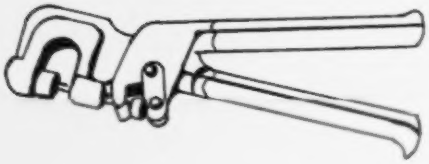
k. ______________________________



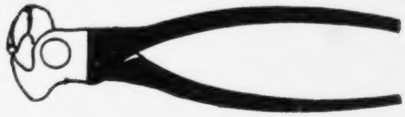
l. ______________________________

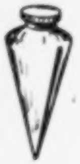
TEST



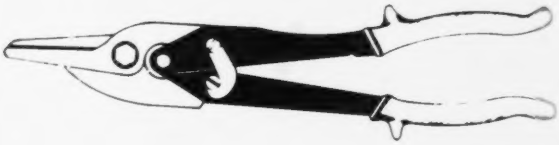


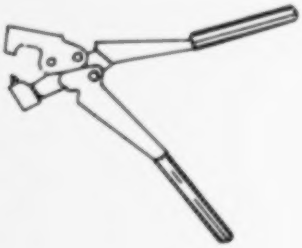
m. ______________________ n. ______________________



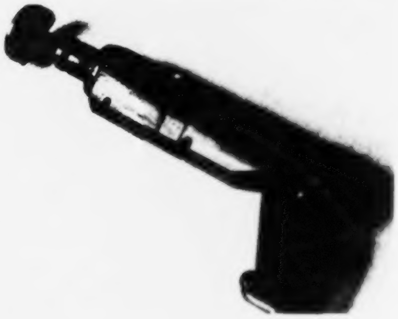


o. ______________________ p. ______________________





q. ______________________ r. ______________________



s. ______________________

TEST

5. List six areas where metal stud systems are used.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

6. Select from the following list advantages of metal stud systems. Write an "X" in the correct blanks.

_____a. Heavy, strong material

_____b. Sound control values

_____c. Waterproof

_____d. Fast installation

_____e. Versatility in meeting job requirements

_____f. Low cost

_____g. Fire resistance

_____h. Durability

7. List three methods used to install fixture supports on metal stud systems.

a. ______________________________

____

____

b. ______________________________

____

____

TEST

c. ____

____

____

(NOTE: Test question 8 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

8. Demonstrate ability to

   a. Layout wall lines, corners, partitions, and openings.

   b. Install a metal stud wall.

   c. Install a metal door frame.

   d. Install a knockdown-type metal door frame.

FIREPROOF METAL STUD CONSTRUCTION
UNIT VI

ANSWERS TO TEST

1. a. 6
b. 9
c. 2
d. 7
e. 3
f. 1
g. 8
h. 5
i. 4

2. Answer should include any eight of the following.

a. Stud
b. Runner
c. Metal furring channel
d. Z-furring channel
e. Resilient channel
f. C-channel (cold rolled)
g. Furring channel clip
h. Door jamb anchor clip
i. Metal angle
j. Adjustable wall framing bracket
k. Breakaway clip
l. Tie wire

3. a. Acorn slotted tapcon anchor
b. Pan head screw
c. Trim head screw
d. Low-profile head screw
e. Pancake head screw
f. Hex washer head screw
g. Bugle head screw
h. Oval head screw
i. Wafer head screw
j. Plastic screw anchor
k. Color nail for vinyl panels
l. Nylon anchor
m. Drive pin
n. Masonry nail
o. Lead screw anchor
p. Annular ring drywall nail
q. Toggle bolt
r. Caulking anchor
s. Self-drilling anchor
t. Nail drive anchor

4. a. Water level
b. Hand punch
c. Power screw gun
d. Power hand shear
e. Magnetic punch
f. Center punch
g. Pop riveter
h. Band saw
i. Side cut pliers
j. Laser beam level
k. Channel stud shear
l. Magnetic hammer
m. Screw gun adapter
n. Metal punch
o. End cut nippers
p. Plumb bob
q. Metal snips
r. Stud crimper
s. Powder-actuated fastener

5. Answers should include any six of the following

a. Area separation walls
b. Shaft walls around elevators
c. Mechanical shafts
d. Return air ducts
e. Stair wells
f. Smoke shafts
g. Interior partition walls
h. Column and pilaster fireproofing
i. Ceilings
j. Curtain wall assemblies

ANSWERS TO TEST

6. b, d, e, f, g, h

7. Answer should include any three of the following

   a. Sheet metal screw attached to 25 gauge minimum sheet metal plate or strip, laminated between face board and baseboard in laminated drywall partitions
   b. Sheet metal screws driven through drywall into steel studs
   c. Notched runner attached to steel studs with pan head screws
   d. Bolt welded to nested 1 1/2 inch channels for mounting hanger brackets for heavy fixtures
   e. Molly bolts installed in drywall
   f. Toggle bolts installed in drywall
   g. Bolt welded to 1 1/2 inch channel and inserted in notches cut in stud for mounting hanger brackets for heavy fixtures
   h. Slotted shelf standards attached to studs or steel reinforcing with screws
   i. Channels attached with 2 1/4 inch screws between studs for cabinets

8. Performance skills evaluated to the satisfaction of the instructor.

INSULATION
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to discuss types of insulation and vapor barriers and to install these materials. The student will show this knowledge by completing the assignment sheet, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with insulation to their correct definitions.
2. Explain the functions of the two basic kinds of insulation.
3. Select from a list benefits of using insulation in a structure.
4. List types of insulation commonly used in commercial construction.
5. Name general classifications of insulation materials.
6. List areas where insulation should be used in commercial construction.
7. List factors that determine the amount of insulation needed for walls, ceilings, and floors.
8. Name types of materials used for vapor barriers.
9. Select from a list methods used to apply insulation and vapor barriers.
10. Estimate the packages of insulation needed to insulate a structure.
11. Demonstrate the ability to
    a. Install vapor barrier and insulation for a concrete slab.
    b. Install blanket insulation in walls.

INSULATION
UNIT I

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Supplements
    1. Supplement #1 — Average Low Temperatures in the United States
    2. Supplement #2 — R-Values per Inch for Various Types of Insulation
    3. Supplement #3 — Insulation Materials
    4. Supplement #4 — Insulation R-Values Required to Meet Comfort Standards
- D. Transparency masters
    1. TM #1 — Installation Methods
    2. TM #2 — Installation Methods (Continued)
    3. TM #3 — Installation Methods (Continued)
- E. Information sheet
- F. Assignment Sheet #1 — Estimate Insulation Materials
- G. Answers to assignment sheet
- H. Job sheets
    1. Job Sheet #1 — Install Vapor Barrier and Insulation for a Concrete Slab
    2. Job Sheet #2 — Install Blanket Insulation in Walls
- I. Test
- J. Answers to test

II. Instructor's guide

- A. Review unit and plan presentation.

SUGGESTED ACTIVITIES

B. Obtain materials to supplement unit.

  1. Ear plugs, thermometers, and a safe heat source
  2. Literature and advertisements from insulation companies or public utilities
  3. Model or cross-section of wall showing insulation
  4. Structural members that have wood rot from excessive moisture
  5. Samples of thermal and acoustical insulation
  6. Plans specifying insulation
  7. Samples of the types of insulation illustrated in the information sheet
  8. Samples of materials used for vapor barriers
  9. Transparency masters and competency profiles

  (NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W., Washington, D.C. 20006, phone 202-393-2040.)

C. Introduce unit.

SUGGESTIONS:

- Demonstrate the effectiveness of insulation in sound- and heat-transfer reduction with simple examples such as ear plugs, thermometers near a heat source with one protected by thermal insulation, etc.
- Discuss common uses of insulation outside construction, such as in water heaters, in refrigerators, and under the hoods of cars. Emphasize that these materials insulate against sound as well as heat.
- Display literature and advertisements from insulation companies or public utilities promoting the use of insulation.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information, assignment, and job sheets.

SUGGESTED ACTIVITIES

G. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I to discuss terms associated with insulation.

   SUGGESTIONS:

   - Show the class a model or wall cross-section to clarify definitions.
   - Display an iced drink in a metal container to demonstrate condensation.
   - Show the class samples of structural members that have developed wood rot from excessive moisture.

2. Use Information Sheet, Section II to discuss the functions of the two basic types of insulation.

   SUGGESTIONS:

   - Exhibit samples of both thermal and acoustical insulation.
   - Provide the class with plans specifying each type of insulation and discuss their applications.

3. Use Information Sheet, Section III to discuss the benefits of using insulation in a structure.

   SUGGESTIONS:

   - Ask the students to read articles or literature from insulation manufacturers and distributors to expand the discussion.
   - Demonstrate the benefits listed in this section of the information sheet.

4. Use Information Sheet, Section IV to discuss types of insulation commonly used in commercial construction.

   SUGGESTIONS:

   - Show the class samples of each type of insulation discussed in this section of the information sheet.
   - Have an insulation installer discuss the procedures involved in installing each type of insulation, the advantages and disadvantages of each type of insulation, and the types of insulation used in your area, especially any not covered in the information sheet.

SUGGESTED ACTIVITIES

5. Use Information Sheet, Section V to discuss general classifications of insulation materials.

   SUGGESTIONS:

   - Show the class Supplement #3 and samples of the various insulation materials discussed in this section of the information sheet.
   - Point out that all materials have some insulating value, including dead air space, and emphasize the differences in resistive values by showing the class Supplement #2.

6. Use Information Sheet, Section VI to discuss areas where insulation should be used in commercial construction.

   SUGGESTIONS:

   - Take the class to visit construction sites to show them where insulation is used. Have each student make a list of the places where insulation was used.
   - Emphasize the need for insulation at any location where heat exchange is likely, and demonstrate air leaks at windows, outlets, etc. Have students compare the lists they made at the job site and add to their lists if necessary.

7. Use Information Sheet, Section VII to discuss factors that determine the amount of insulation needed for walls, ceilings, and floors.

   SUGGESTIONS:

   - Demonstrate how the three factors discussed in this section of the information sheet are interrelated.
   - Show the class Supplements #1, #2, and #4 to relate temperature and comfort level to insulation requirements.
   - Have students or groups of students to ask a utility company or other agency to perform an energy audit of their homes; each student should then prepare a report comparing the results of the energy audit to the cost of fuel and the cost of insulation.
   - Have an insulation installer talk to the class and compare the costs of insulating new construction to insulating an existing structure.

8. Use Information Sheet, Section VIII to discuss materials used for vapor barriers, providing students with samples of each material discussed in this section of the information sheet.

SUGGESTED ACTIVITIES

9. Use Information Sheet, Section IX and Transparencies #1 through #3 to discuss methods used to apply insulation and vapor barriers.

   SUGGESTIONS:

   - Demonstrate each method discussed in this section of the information sheet and relate each method to specific types of insulation.
   - Demonstrate the procedures in Job Sheets #1 and #2.
   - Have the students complete Job Sheets #1 and #2.

10. Use Information Sheet, Section X to discuss estimating the packages of insulation needed to insulate a structure.

    SUGGESTIONS:

    - Emphasize the types of insulation materials commonly used in your area.
    - Discuss Assignment Sheet #1.
    - Have students complete Assignment Sheet #1.

H. Give test.

I. Critique test and discuss in class.

J. Reteach if necessary.

K. Complete appropriate sections of competency profiles.

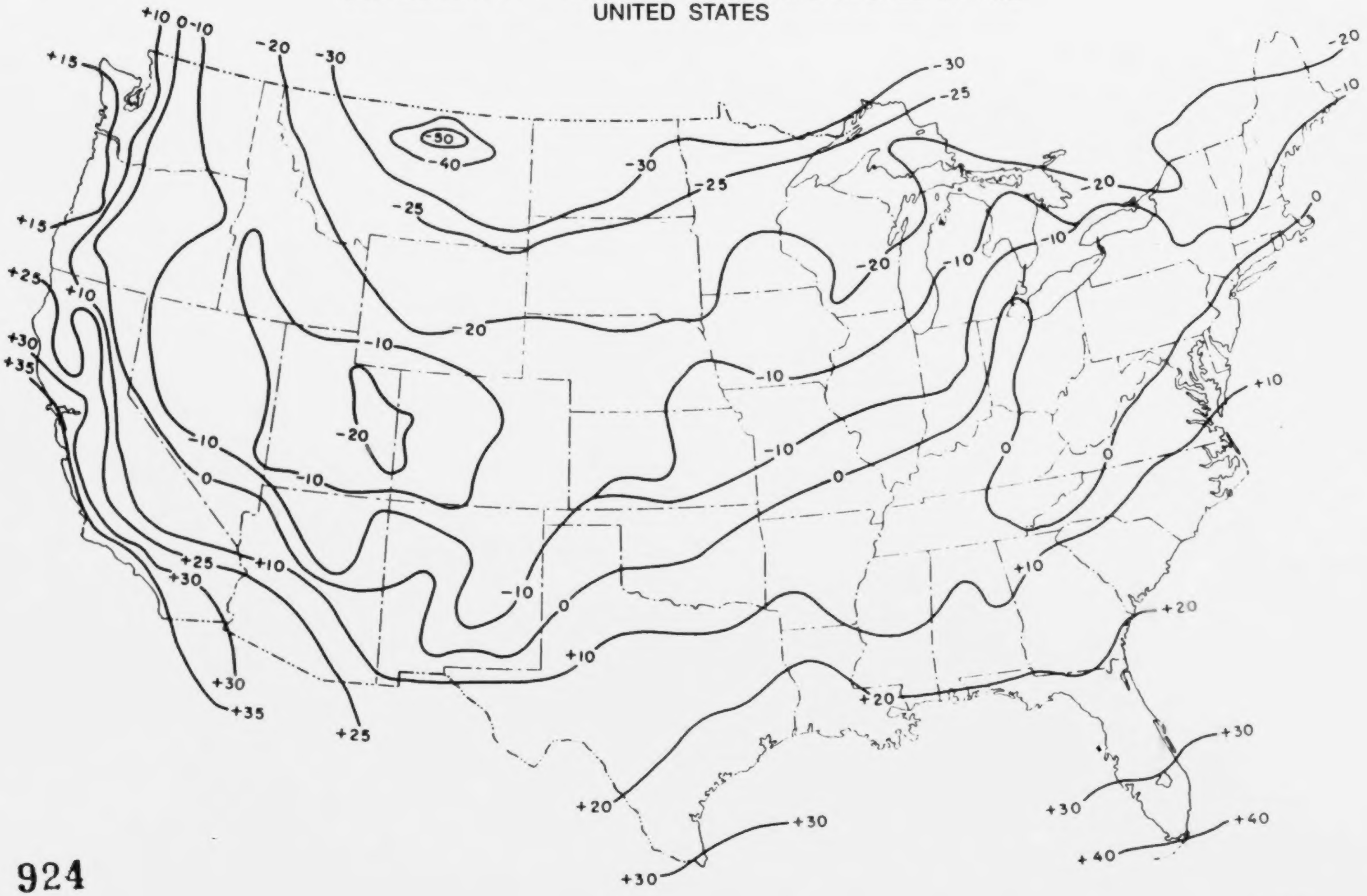
III. Unit references

A. Hepler, Donald E., and Paul I. Wallach *Architecture Drafting and Design*, 3rd ed. New York: McGraw-Hill, 1977.

B. Wagner, Willis H. *Modern Carpentry*. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1976.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — AVERAGE LOW TEMPERATURES IN THE UNITED STATES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SUGGESTED ACTIVITIES

SUPPLEMENT #2 — R-VALUES PER INCH FOR VARIOUS TYPES OF INSULATION

Material	R-Value per Inch
Polyisocyanurate	7.2
Extruded styrene	5.2
Asphalt shingles	4.8
Expanded polystyrene	4.0
Cellulose	3.8
Fiberglass (batts)	3.2
Rock wool	3.0
Fiberglass loose fill (standard grade)	2.2
Fiberglass loose fill (premium grade)	2.7
Fir, pine	1.3
Glass	0.9
Brick	0.2
Cement plaster	0.2

(NOTE: Fiberglass loose fill has a wide range of R/inch values depending on brands.)

SUGGESTED ACTIVITIES

SUPPLEMENT #3 — INSULATION MATERIALS

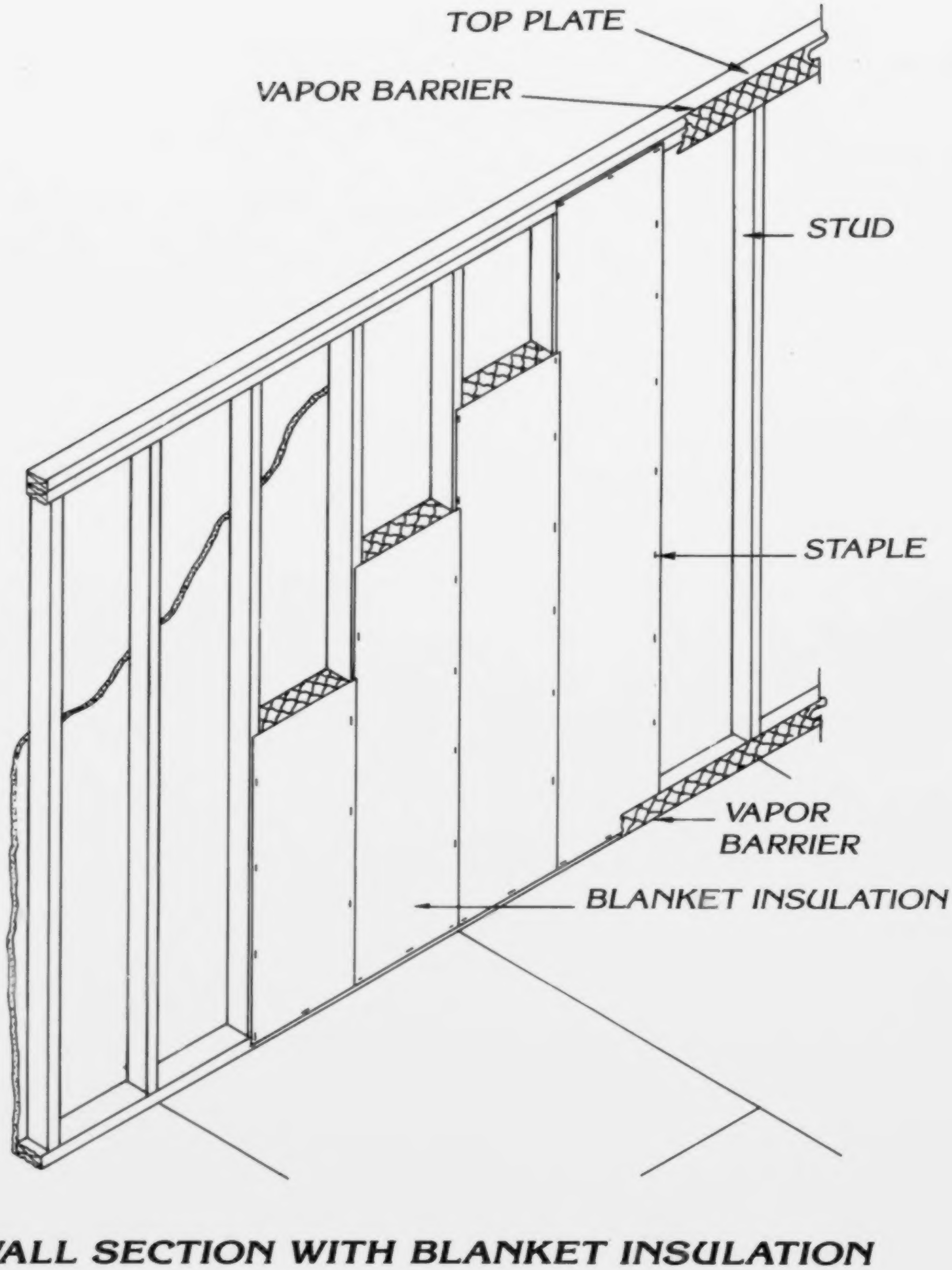
Classification	Material	Comments
Mineral	Rock Slag Glass Vermiculite	Rock and slag are used to produce "wool" by grinding and melting the materials and blowing them into a fine mass
Vegetable (natural)	Wood Sugar cane Corn stalks Cotton Cork Redwood bark Sawdust or shavings	Many vegetable products are processed and formed into various shapes, including blankets and rigid boards
Plastic	Polystyrene Rubber	—
Metal	Foil Tin plate Copper Aluminum	Metallic insulating materials are generally applied to rigid boards or papers and are used primarily for their reflective value

SUGGESTED ACTIVITIES

SUPPLEMENT #4 — INSULATION R-VALUES REQUIRED TO MEET COMFORT STANDARDS

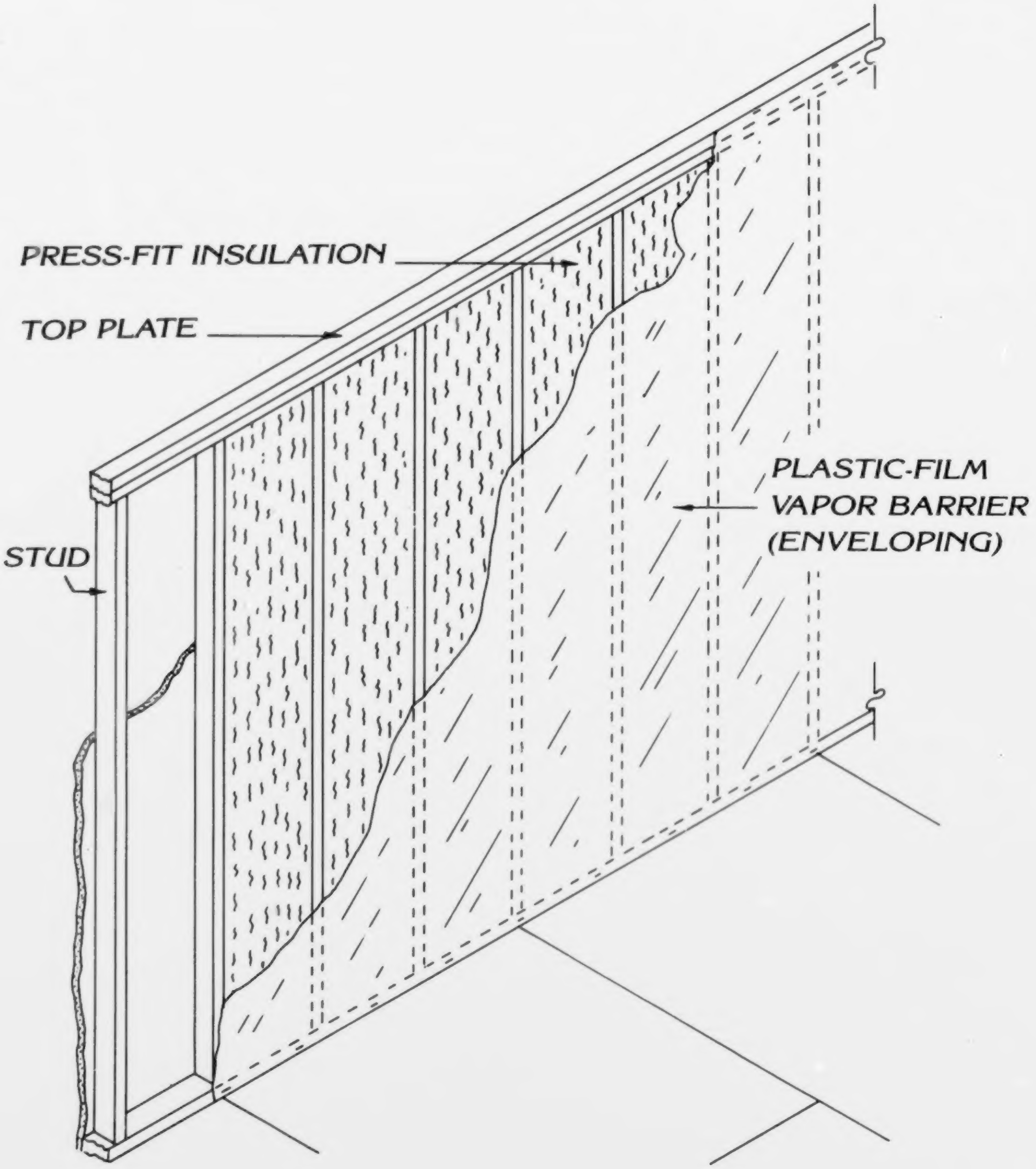
Standard	Insulation Location	Insulation R-Value
All-weather comfort standard	Walls	R 19
	Ceilings	R 30
	Floors	R 19
Moderate comfort standard	Walls	R 13
	Ceilings	R 26
	Floors	R 13
Minimum comfort standard	Walls	R 11
	Ceilings	R 19
	Floors	R 11

Installation Methods


TOP PLATE
VAPOR BARRIER
STUD
STAPLE
VAPOR BARRIER
BLANKET INSULATION

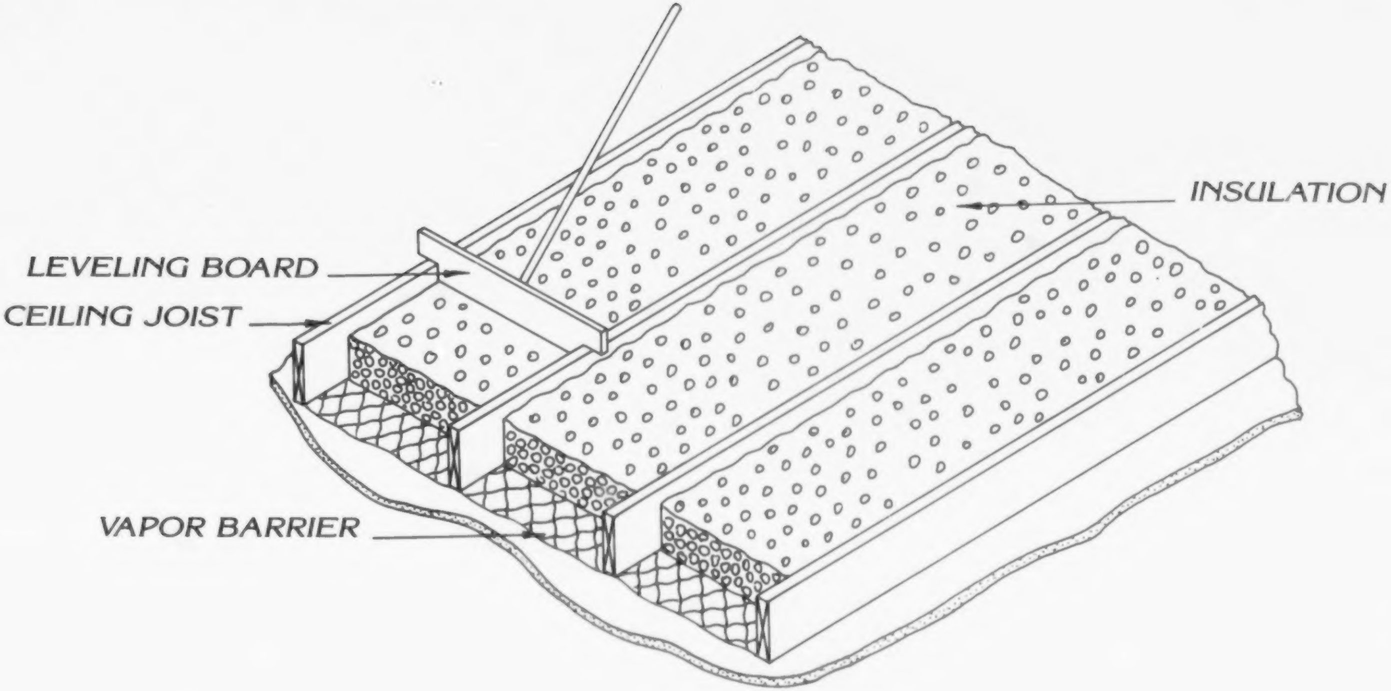
WALL SECTION WITH BLANKET INSULATION

Installation Methods
(Continued)


PRESS-FIT INSULATION
TOP PLATE
STUD
PLASTIC-FILM
VAPOR BARRIER
(ENVELOPING)

WALL SECTION WITH PRESS-FIT INSULATION

Installation Methods
(Continued)


INSULATION
LEVELING BOARD
CEILING JOIST
VAPOR BARRIER

CEILING WITH FULL INSULATION

INSULATION
UNIT I

INFORMATION SHEET

I. Terms and definitions associated with insulation

   A. Insulation — Material used in walls, ceilings, and floors to retard the passage of heat and sound

      (NOTE: Acoustical insulation retards the passage of sound and thermal insulation retards the passage of heat.)

   B. Reflective insulation — Metal-surfaced insulating material exposed to an air space to reduce heat radiation across the air space

   C. Perimeter insulation — Insulating material installed at foundation and floor slab around perimeter of structure

   D. Condensation — Process by which vapor becomes liquid

   E. Moisture penetration — Process by which moisture moves into a structure

   F. Vapor barrier — Material that prevents the passage of moisture or vapor into or through structural elements

II. Functions of the two basic kinds of insulation

   (NOTE: Basically, two types of insulation are used in commercial construction: thermal and acoustical.)

   A. Thermal insulation — Retards the transfer of heat from inside a structure to the outside and from the outside into the structure

   B. Acoustical insulation — Retards the passage of sound waves from the outside into a structure or from one room to another within the structure

III. Benefits of using insulation in a structure

   A. Prevents rapid temperature changes

   B. Reduces fuel expenses

   C. Retards or resists the spread of fire

   D. Prevents condensation

   E. Reduces noise from the outside

   F. Helps absorb echoes

INFORMATION SHEET

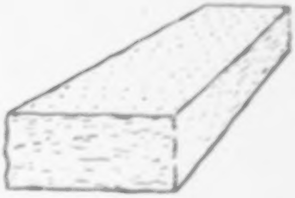
IV. Types of insulation commonly used in commercial construction (Figures 1-10)

(NOTE: There are many types of insulation other than those listed below. Examples of other types of insulation include lightweight aggregates such as vermiculite, perlite, blast furnace slag, burned clay products, and cinders. Aggregates are commonly used in plaster and concrete to improve the insulating qualities of these materials.)

A. Flexible batt insulation

EXAMPLE:

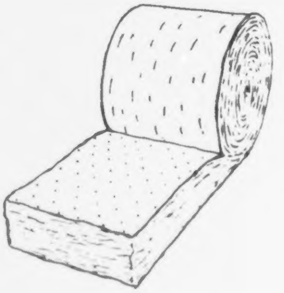
FIGURE 1



B. Flexible blanket insulation

EXAMPLE:

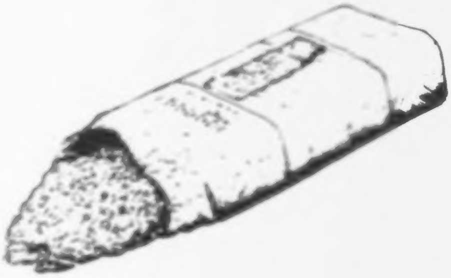
FIGURE 2



C. Loose-fill insulation

EXAMPLE:

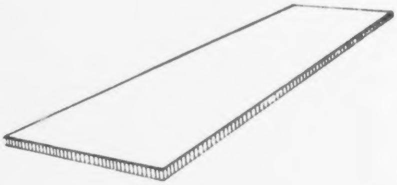
FIGURE 3



D. Rigid board insulation

EXAMPLE:

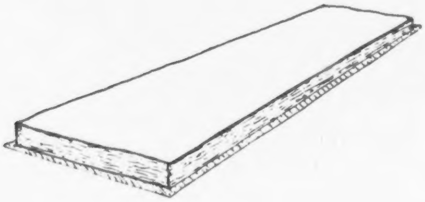
FIGURE 4



E. Reflective insulation

EXAMPLE:

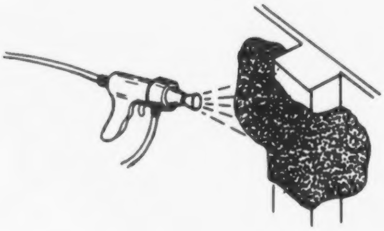
FIGURE 5



F. Adhesive-type insulation

EXAMPLE:

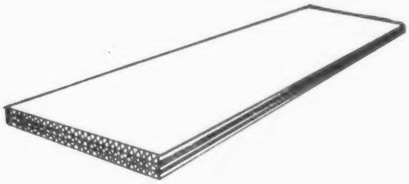
FIGURE 6



G. Corrugated-paper insulation

EXAMPLE:

FIGURE 7

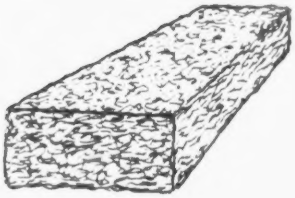


H. Friction-batt insulation

(NOTE: Friction-batt insulation is fiberglass insulation without a paper cover.)

EXAMPLE:

FIGURE 8



INFORMATION SHEET

I. Foamed-plastic insulation

EXAMPLES:

FIGURE 9: Blown-in foamed-plastic insulation

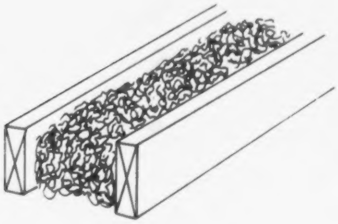
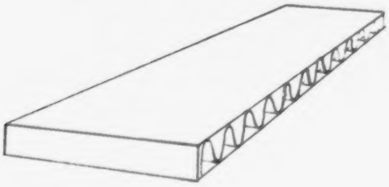


FIGURE 10: Rigid-board foamed-plastic insulation



V. General classifications of insulation materials

- A. Mineral
- B. Vegetable (natural)
- C. Plastic
- D. Metal

VI. Areas where insulation should be used in commercial construction

(NOTE: In general, insulation should be used where any structural surface is exposed to thermal exchange.)

- A. Over ground in crawl space
- B. Around perimeter of concrete floors and foundations
- C. Between floor joists
- D. Between wall studs
- E. Above ceilings
- F. In roof structure

(NOTE: In the roof structure, the vapor barrier must always face the heated area [toward interior], and for proper air circulation, the air space must always be maintained between the insulation and the roof sheathing.)

INFORMATION SHEET

VII. Factors that determine the amount of insulation needed for walls, ceilings, and floors

A. Average low and high temperatures

(NOTE: Although the average low temperature is normally used as the basis for determining insulation requirements, the average high temperature of an area should also be considered in warm climates to prevent loss of cool inside air and penetration of hot outside air.)

B. Level of comfort desired

(NOTE: *Comfort level* refers to the inside temperature that must be maintained for personal comfort. Comfort levels are generally divided into three standards: the all-weather standard, the moderate standard, and the minimum standard. To meet the all-weather standard, the amount of insulation provided must be adequate to maintain a desired temperature even during periods of extreme outside temperatures. To meet the moderate standard, the insulation provided must be adequate to maintain a desired temperature during periods of average outside temperature extremes. And, to meet the minimum standard, the amount of insulation provided must only be adequate enough to reduce heat exchange.)

C. Cost

(NOTE: When determining the amount of insulation needed, compare the insulation cost to the cost of fuel needed to maintain a given comfort level; also include in your comparison the cost of materials and labor and the interest paid on the increased cost. Ensure that the cost of the insulation will pay for itself in terms of all these expenses.)

VIII. Materials used for vapor barriers

(NOTE: Many insulation materials and interior surface materials are backed with vapor barriers which when installed properly are usually sufficient to resist moisture penetration. The following materials are used as vapor barriers either singly or in combinations.)

A. Asphalt-coated paper

B. Aluminum foil

C. Polyethylene film

D. Roll roofing

IX. Methods used to apply insulation and vapor barriers

A. Stapled

INFORMATION SHEET

(NOTE: Insulation and vapor barriers may be stapled down with either a hand-held or pneumatic stapler.)

B. Nailed

(NOTE: Either a hammer or a pneumatic nailer may be used in nailing insulation and vapor barriers.)

C. Pressed in place and held with mastic

D. Hand-poured

(NOTE: Loose-fill material is often hand-poured.)

E. Blown in

(NOTE: Loose-fill material may be blown in place.)

F. Sprayed on

(NOTE: Adhesive-type material is sprayed on.)

G. Rolled out and taped at joints

(NOTE: When polyethylene film or roll roofing is installed, the material should be lapped at least 4 inches on all edges and should extend well up the foundation walls. Tape to seal all edges and to hold the material up on the foundation walls.)

X. Estimating packages of insulation needed to insulate a structure

(NOTE: When estimating materials, round up to the next even foot.)

A. Calculate square footage of exterior walls to be insulated

1. Determine from plans length of perimeter of each exterior wall

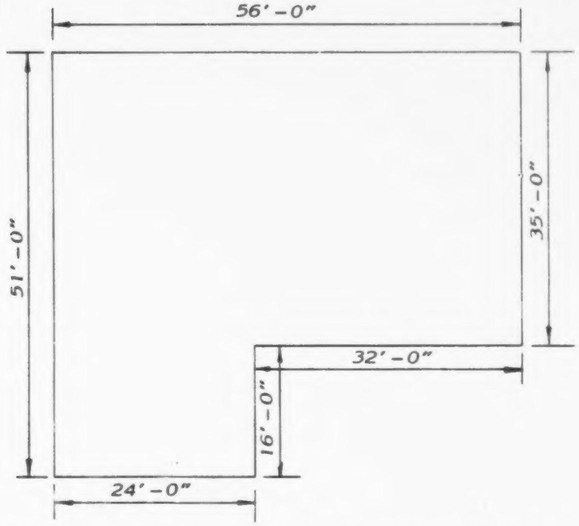
2. Add lengths of all walls to find the structure's total perimeter

EXAMPLE: If walls of a structure are 56 feet, 35 feet, 32 feet, 16 feet, 24 feet, and 51 feet (See Figure 11), then

56′ + 35′ + 32′ + 16′ + 24′ + 51′ = 214′ = Structure's Total Perimeter

INFORMATION SHEET

FIGURE 11



3. Multiply total perimeter by ceiling height to find total square footage of walls

   EXAMPLE: If the total perimeter of a structure is 214 feet and the ceiling height is 8 feet, then

   214' × 8' = 1,712 sq ft = Total Square Footage of Exterior Walls

4. Determine from plans the total square footage of each opening

5. Add the square footage of all openings to find total square footage of openings

6. Subtract total square footage of openings from total square footage of walls to find square footage of walls to be insulated

   EXAMPLE: If the total square footage of walls is 1,712 square feet and the total square footage of openings is 174 square feet, then

   1,712 sq ft − 174 sq ft = 1,538 sq ft = Square Footage of Exterior Walls to Be Insulated

B. Calculate square footage of ceilings to be insulated

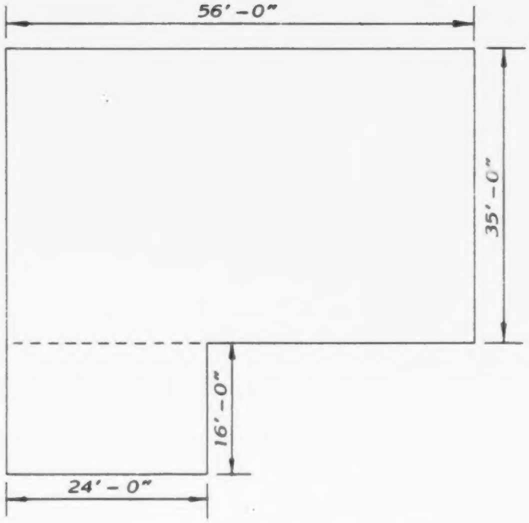
   (NOTE: The square footage of floor to be insulated is the same as the square footage of ceiling to be insulated.)

   1. Divide ceiling into rectangular or square areas and determine from plans the length and width of each area (See Figure 12)

INFORMATION SHEET

EXAMPLE:

FIGURE 12



2. Multiply length times width to find square footage of each ceiling area

EXAMPLE: If there are ceiling areas of 56' × 35' and 24' × 16', then

56' × 35' = 1,960 sq ft
24' × 16' = 384 sq ft

3. Add the square footage of all areas to find total square footage

EXAMPLE: If there are ceiling areas of 1,960 square feet and 384 square feet, then

1,960 sq ft + 384 sq ft = 2,344 sq ft = Total Square Footage of Ceilings to Be Insulated

C. Calculate total square footage of area to be insulated — Add square footage of exterior walls to be insulated to square footage of ceilings

EXAMPLE: If the total square footage of exterior walls is 1,538 square feet and the total square footage of ceilings is 2,344 square feet, then

1,538 sq ft + 2,344 sq ft = 3,882 sq ft = Total Square Footage of Area to Be Insulated

INFORMATION SHEET

D. Calculate packages of insulation needed to insulate structure

1. Determine number of packages needed to cover square footage of area to be insulated

   (NOTE: Insulation packaging varies considerably with different manufacturers, types of materials, R-factors, and width and thicknesses of materials. See Table 1.)

   EXAMPLE:

TABLE 1: Coverage of Insulation in Packaging by Various Manufacturers

R-Value	Thickness	Width	Length	Total Coverage
38	12"	16"	48"	32 sq ft per pkg
38	13"	16"	48"	64 sq ft per pkg
19	6½"	15"	39½"	49 sq ft per pkg
19	6¼"	15"	94"	48.96 sq ft per pkg
19	6½"	15"	24"	120 sq ft per pkg

2. Divide square footage of area to be insulated by amount of coverage per package to find the number of packages of insulation needed

INSULATION
UNIT I

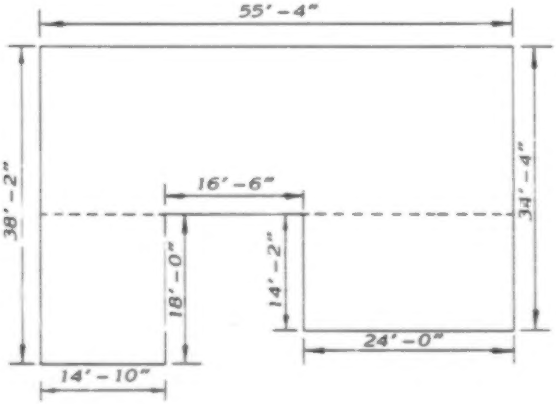
ASSIGNMENT SHEET #1 — ESTIMATE INSULATION MATERIALS

NAME ______________________________ SCORE ______________

The carpenter must practice estimating insulation materials because so many things must be considered. There are many different types of insulation materials, most of which may be applied in various forms, such as batts, loose fill, and rigid. Additionally, the amount of material required to obtain a particular R-factor must be considered as well as the most effective placement of that material.

Use the illustrations and dimensions given to estimate insulation materials needed for each application method described. Show your work.

A. Estimate wall and ceiling insulation for the structure illustrated below. Finished wall height is 10′-0″ and total area of wall openings is 220 square feet.



1. Wall area to be insulated = ____________ square feet

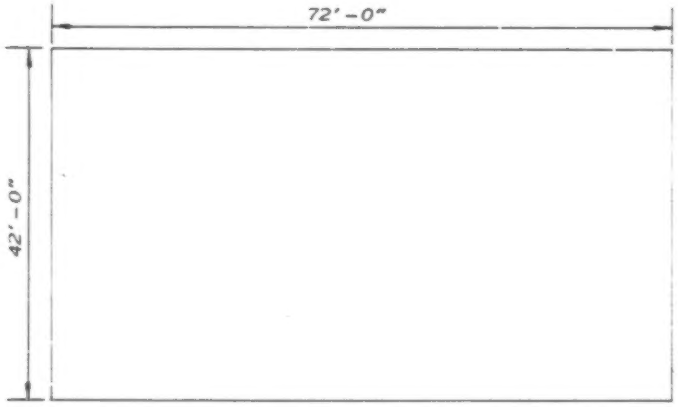
2. Number of rolls of R-19 batt insulation required for walls with 120 square feet per roll = ____________ rolls

3. Ceiling area to be insulated = ____________ square feet

4. Number of packages of loose-fill insulation for R-38 in the ceiling if each package will cover 64 square feet = ____________ packages

ASSIGNMENT SHEET #1

B. Estimate insulation materials needed for the structure illustrated below. The building will be constructed with a crawl space, 12′-0″ ceiling height, and 178 square feet of wall openings.



1. Packages of R-19 insulation required for walls at 49 square feet per package = ____________packages

2. Packages of R-38 insulation required for ceiling at 64 feet per package = ____________packages

3. Packages of R-19 insulation required for floor at 49 square feet per package = ____________packages

INSULATION
UNIT I

ANSWERS TO ASSIGNMENT SHEET

Assignment Sheet #1

(NOTE: Evaluate the student's work as well as the answers since answers may vary due to rounding.)

A. 1. 1,930
   2. 17
   3. 1,806
   4. 29

B. 1. 53
   2. 48
   3. 62

INSULATION
UNIT I

JOB SHEET #1 — INSTALL VAPOR BARRIER AND INSULATION FOR A CONCRETE SLAB

I. Tools and materials

   A. 1" × 2' × 8' rigid insulation

   B. Polyethylene plastic film

   C. Mastic or special adhesive

   D. Utility knife or shears

   E. Putty knife or pointing trowel

   F. Folding rule or steel tape

II. Procedure

   A. Clean out along inside of foundation to a depth of 2'-4" below finish-floor elevation

   B. Install rigid insulation on edge (vertically) along the inside of the two long sides of the foundation

   C. Install rigid insulation on edge along the inside of the other two ends of the foundation

   D. Be sure that sand fill is graded to proper elevation for floor slab, then remove enough sand around the foundation's perimeter to allow for the 1-inch insulation

   E. Install horizontal pieces of insulation around the inside perimeter of the foundation, lapping the pieces over the top of the vertical pieces and placing them tightly against the foundation

   F. Lay a roll of plastic film at one end of the floor base and roll out film to the other end; measure this distance

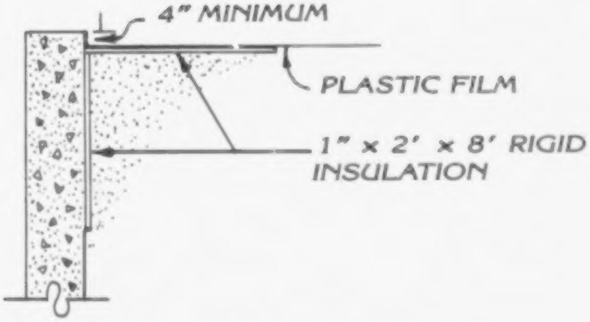
   G. Add 8 inches to distance determined in step F and cut plastic

   (NOTE: Plastic film should be carried up at least 4 inches at each foundation wall.)

   H. Unfold length of plastic and lay out flat on the sand fill, allowing 4 inches to carry the film up the foundation wall at both ends and 4 inches to carry the film up the side foundation wall (See Figure 13)

JOB SHEET #1

FIGURE 13


4" MINIMUM
PLASTIC FILM
1" × 2' × 8' RIGID INSULATION

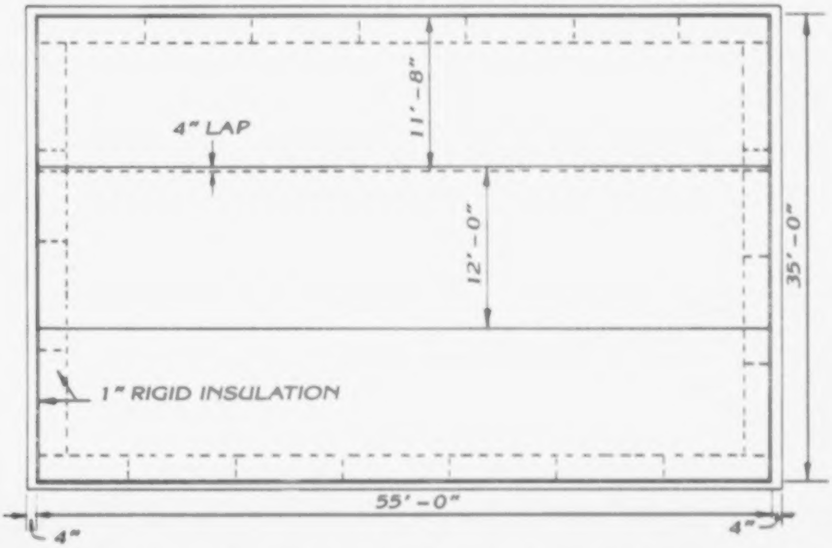
I. Roll out another piece of plastic to length determined in steps F and G and cut

J. Unfold this length and lay out on sand fill, allowing 4 inches to carry the film up the foundation wall at each end and 4 inches to lap this piece over the first piece

K. Continue following the procedures in steps I and J until entire area is covered (Figure 14)

(NOTE: If you end up with only a narrow strip to cover, you may want to piece it in with short pieces rather than waste a lot of material.)

FIGURE 14


11'-8"
4" LAP
12'-0"
35'-0"
1" RIGID INSULATION
55'-0"
4"
4"

L. Use mastic or adhesive to seal the seams where the plastic strips overlap and to hold the ends and edges up on the foundation walls

M. Clean up area and put away tools and materials

INSULATION
UNIT I

JOB SHEET #2 — INSTALL BLANKET INSULATION IN WALLS

I. Tools and materials

- A. Utility knife or shears
- B. Hand or pneumatic stapler
- C. Staples
- D. Tape
- E. Insulation batts
- F. Pencil

II. Procedure

- A. Measure space to be filled with insulation, and add 2 or 3 inches to that measurement

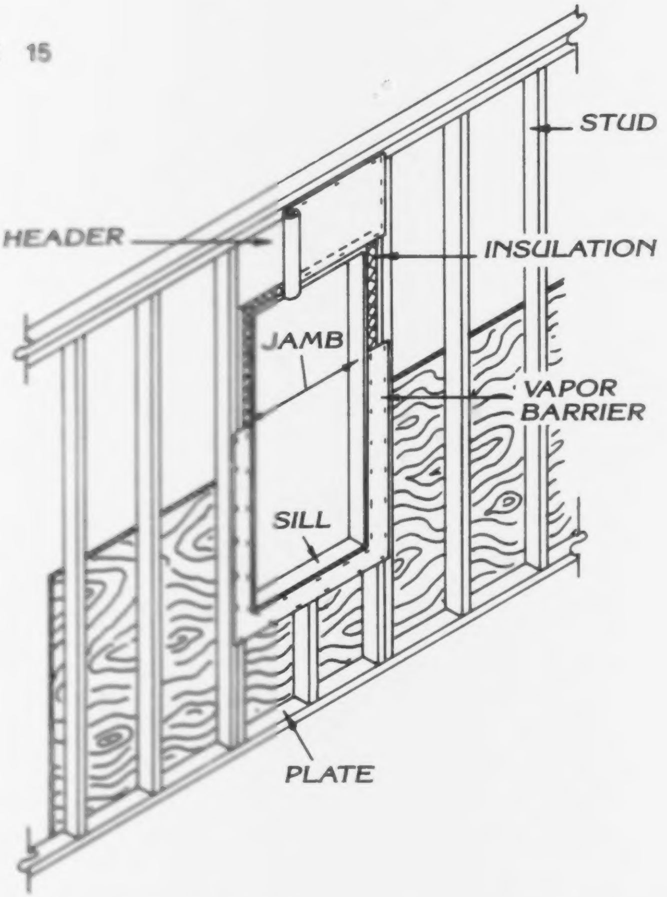
  (NOTE: Insulation should be 2 to 3 inches longer than the space to be filled; this allows enough length so that some of the batting can be removed from both ends to allow nail flanges on top and bottom.)

- B. Mark on the floor the length determined in step A
- C. Roll out insulation between marks on floor and cut insulation to length

  (NOTE: Save cut-off ends and pieces so that they may be used to fill small spaces around windows, doors, electrical boxes, and any other small opening. See Figure 15.)

JOB SHEET #2

FIGURE 15



D. Place insulation in wall opening with nail flange over top plate and side tabs over studs; carefully fit insulation around pipes, conduits, electrical boxes, and window and door frames (See Figure 15)

E. Staple the top nail flange to top plate and then, working from top to bottom and alternating from one side to the other, staple the side tabs to the studs, placing staples no more than 12 inches apart

F. Staple bottom nail flange to soleplate

G. Follow procedures in steps A through G until all walls are insulated

H. Check to see that no openings were missed and that all the insulation is properly installed; fill these openings as necessary

I. Clean up area and put away tools and materials

INSULATION
UNIT I

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with insulation to their correct definitions. Write the correct numbers in the blanks.

_____a. Process by which vapor becomes liquid

_____b. Material used in walls, ceilings, and floors to retard the passage of heat and sound

_____c. Process by which moisture moves into a structure

_____d. Insulating material installed at foundation and floor slab around perimeter of structure

_____e. Metal-surfaced insulating material exposed to an air space to reduce heat radiation across the air space

_____f. Material that prevents the passage of moisture or vapor into or through structural elements

1. Insulation
2. Perimeter insulation
3. Condensation
4. Vapor barrier
5. Moisture penetration
6. Reflective insulation

2. Explain the functions of the two basic kinds of insulation.

a. Thermal insulation — ______________________________

____

____

____

____

b. Acoustical insulation — ______________________________

____

____

____

____

TEST

3. Select from the following list benefits of using insulation in a structure. Write an "X" in the blank before each correct answer.

______a. Reduces noise from the outside

______b. Retards or resists the spread of fire

______c. Reduces fuel expenses

______d. Increases rapid temperature changes in a structure

______e. Helps absorb echoes

______f. Prevents condensation

4. List four types of insulation commonly used in residential construction.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

5. Name three general classifications of insulation materials.

a. ______________________________

b. ______________________________

c. ______________________________

6. List four areas where insulation should be used in commercial construction.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

7. List factors that determine the amount of insulation needed for walls, ceilings, and floors.

a. ______________________________

b. ______________________________

c. ______________________________

TEST

8. Name three types of materials used for vapor barriers.

a. ______________________________

b. ______________________________

c. ______________________________

9. Select from the following list methods used to apply insulation and vapor barriers. Write an "X" in the blank before each correct answer.

______a. Stapled

______b. Nailed

______c. Fastened with powder-actuated tool

______d. Rolled out and taped at joints

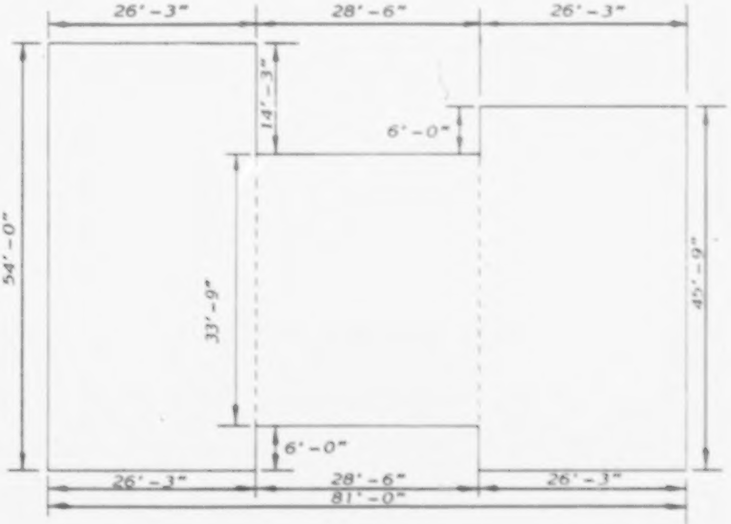
______e. Blown in

______f. Pressed in place and held with mastic

______g. Hand-poured

______h. Sprayed on

10. Estimate the packages of insulation needed for the structure illustrated below. The structure has 8-foot ceilings and 278 square feet of wall openings. Show your work. Write the correct answers in the blanks on the following page.



TEST

a. Total packages of R-11 insulation needed for walls at 96 square feet per package =

______________________ packages

b. Total packages of R-38 insulation needed for ceilings at 64 square feet per

package = ______________________ packages

(NOTE: Test question 11 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

11. Demonstrate the ability to

    a. Install vapor barrier and insulation for a concrete slab

    b. Install blanket insulation in walls.

INSULATION
UNIT I

ANSWERS TO TEST

1.
   a. 3
   b. 1
   c. 5
   d. 2
   e. 6
   f. 4

2. Explanation should include the following
   a. Retards the transfer of heat from inside a structure to the outside and from the outside into the structure
   b. Retards the passage of sound waves from the outside into a structure or from one room to another within the structure

3. a, b, c, e, f

4. Answer should include any four of the following
   a. Flexible batt insulation
   b. Flexible blanket insulation
   c. Loose-fill insulation
   d. Rigid board insulation
   e. Reflective insulation
   f. Adhesive-type insulation
   g. Corrugated-paper insulation
   h. Friction-batt insulation
   i. Foamed-plastic insulation

5. Answer should include any three of the following
   a. Mineral
   b. Vegetable (natural)
   c. Plastic
   d. Metal

6. Answer should include any four of the following
   a. Over ground in crawl space
   b. Around perimeter of concrete floors and foundations
   c. Between floor joists
   d. Between wall studs
   e. Above ceilings
   f. In roof structure

7.
   a. Average low and high temperatures
   b. Level of comfort desired
   c. Cost

ANSWERS TO TEST

8. Answer should include any three of the following

   a. Asphalt-coated paper
   b. Aluminum foil
   c. Polyethylene film
   d. Roll roofing

9. a, b, d, e, f, g, h

10. a. 22
    b. 58

11. Performance skills evaluated to the satisfaction of the instructor.

DRYWALL

UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to discuss gypsum wallboard and estimate and install wallboard materials. The student will show this knowledge by completing the assignment sheets, job sheets, and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with drywall to their correct definitions.
2. Name types of gypsum wallboard.
3. Select from a list standard sizes of gypsum wallboard.
4. Identify standard edge shapes of gypsum wallboard.
5. State benefits of using gypsum wallboard.
6. Describe types of base or construction where wallboard is used.
7. Identify hardware and fasteners used with gypsum wallboard.
8. Select from a list types of finishes that may be applied to gypsum wallboard.
9. Estimate materials needed to dry wall a structure.
10. Demonstrate the ability to
    a. Install gypsum wallboard.
    b. Finish wallboard joints and depressions.
    c. Apply laminated gypsum wallboard.

DRYWALL
UNIT II

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Transparency masters

      1. TM #1 — Planning the Job

      2. TM #2 — Estimating Materials

      3. TM #3 — Tools Required

      4. TM #4 — Cutting Gypsum Wallboard

      5. TM #5 — Ceiling Installation

      6. TM #6 — Wall Application

      7. TM #7 — Metal Corner Bead

      8. TM #8 — Joint Finishing

      9. TM #9 — Applying Bedding Compound

      10. TM #10 — Applying Wallboard Tape

      11. TM #11 — Applying Finishing Coats

      12. TM #12 — Finishing Nailheads

      13. TM #13 — Finishing End Joints

      14. TM #14 — Finishing Metal Corner Bead

   D. Information sheet

   E. Assignment sheets

      1. Assignment Sheet #1 — Estimate Drywall Materials for a Room

      2. Assignment Sheet #2 — Estimate Drywall Materials for an Office Building

   F. Answers to assignment sheets

SUGGESTED ACTIVITIES

G. Job sheets

    1. Job Sheet #1 — Install Gypsum Wallboard
    2. Job Sheet #2 — Finish Wallboard Joints and Depressions
    3. Job Sheet #3 — Apply Laminated Gypsum Wallboard

H. Test

I. Answers to test

II. Instructor's guide

A. Review unit and plan presentation.

B. Obtain materials to supplement unit.

    1. Cut-away wall section showing drywall installation
    2. Samples of the various types of wallboard
    3. Literature from gypsum wallboard manufacturers
    4. Models of the various types of base construction where wallboard is used
    5. House plans illustrating wallboard installation
    6. Samples of hardware and fasteners used with gypsum wallboard
    7. Plans and schedules that show wallboard finish specifications
    8. Transparencies and competency profiles

(NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W., Washington, D.C. 20006, phone 202-393-2040.)

C. Introduce unit.

SUGGESTIONS:

- Demonstrate or have a craftsman demonstrate the installation of plaster walls and ceilings and point out the time and labor plastering requires.
- Provide the class with representative costs for installing 100 square feet of plaster as compared to 100 square feet of drywall; also compare time requirements for the two jobs.

SUGGESTED ACTIVITIES

- Have a former student who works primarily as a drywall installer talk to the class about his or her job and training.

D. Provide students with objective sheet; discuss unit and specific objectives.

E. Provide students with information, assignment, and job sheets.

F. Discuss information, assignment, and job sheets.

1. Use Information Sheet, Section I to discuss terms and definitions associated with drywall.

   SUGGESTIONS:

   - Show the class samples of materials when possible.
   - Show the class a cut-away wall section display with the drywall at various stages of installation to illustrate terms.

2. Use Information Sheet, Section II to discuss types of gypsum wallboard.

   SUGGESTIONS:

   - Invite a representative from a gypsum wallboard manufacturer or distributor to discuss the various types of gypsum wallboard.
   - Provide students with samples of each type of wallboard discussed in this section of the information sheet.
   - Take the class to visit a gypsum wallboard manufacturing plant.

3. Use Information Sheet, Section III to discuss standard sizes of gypsum wallboard.

   SUGGESTIONS:

   - Discuss reasons for and applications of the various sizes of wallboard.
   - Have students survey local distributors to determine what sizes of wallboard are normally available and which sizes must be special ordered.
   - Take the class to visit construction sites where a variety of wallboard sizes and types of gypsum wallboard are being used.

4. Use Information Sheet, Section IV to discuss edge shapes of gypsum wallboard.

   SUGGESTIONS:

   - Have a professional drywall installer discuss reasons for the various shapes and installation techniques required.

SUGGESTED ACTIVITIES

- Have students survey manufacturers and distributors to determine which edge shapes are available for the various types and sizes of wallboard.

5. Use Information Sheet, Section V to discuss benefits of using gypsum wallboard.

   SUGGESTIONS:

   - Demonstrate benefits, ease of repair, noncombustibility, etc.
   - Provide students with manufacturer's or association literature describing the benefits of gypsum wallboard.
   - Have a professional wallboard installer discuss the limitations and restrictions of using gypsum wallboard.

6. Use Information Sheet, Section VI to discuss types of base construction where wallboard is used.

   SUGGESTIONS:

   - Display models of the various construction methods discussed in this section of the information sheet.
   - Take the class to visit construction sites to view various types of wallboard installations.
   - Show the class plans for the various types of installations, and discuss the purpose of each type.

7. Use Information Sheet, Section VII to discuss hardware and fasteners used with gypsum wallboard.

   SUGGESTIONS:

   - Display samples of each type of hardware and fastener illustrated in this section of the information sheet.
   - Demonstrate the use of each type of hardware or fastener or invite drywall installers to demonstrate the use of each type, emphasizing hardware and fasteners commonly used in your area.

8. Use Information Sheet, Section VIII to discuss types of finishes for gypsum wallboard.

   SUGGESTIONS:

   - Have the class study plans and schedules to review how finishes are specified.

SUGGESTED ACTIVITIES

- Take the class to visit construction sites to see the application of various finishes over gypsum wallboard; try to see various stages of the application procedure from bare walls marked for the type of application to finished walls.

9. Use Information Sheet, Section IX to discuss estimating materials needed to drywall a structure.

   SUGGESTIONS:

   - Discuss Assignment Sheets #1 and #2.
   - Have students complete Assignment Sheets #1 and #2.
   - Provide students with plans and have them estimate materials, write up orders, and determine costs.

G. Use Transparencies #1 through #14 to discuss the procedures in installing and finishing drywall. Emphasize careful handling of wallboard, safety requirements due to size and weight of wallboard materials, and power-tool safety.

H. Have students complete Job Sheets #1 and #2.

I. Discuss the procedures in Job Sheet #3.

J. Have students complete Job Sheet #3.

K. Give test.

L. Critique test and discuss in class.

M. Reteach if necessary.

N. Complete appropriate sections of competency profiles.

III. Unit references

A. *Goldblatt Tool Company Catalog*. Kansas City, Kansas: Goldblatt Tool Company, 1983.

B. Hendrix, Laborn J. "Bud." *Commercial Carpentry*. Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

C. Hendrix, Laborn J. "Bud." *Residential Carpentry*, Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1985.

D. Wagner, Willis H. *Modern Carpentry*. South Holland, Illinois: The Goodheart-Willcox Company, Inc., 1976.

SUGGESTED ACTIVITIES

E. Georgia Pacific Corporation, Atlanta, Georgia.

F. *Gypsum Construction Handbook*, 2nd ed., Chicago, Illinois; United States Gypsum Company, Chicago, Illinois, 1982.

1 Planning the Job

THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA

A little thought and planning before you start your project can result in a better-appearing job and a savings in materials and time. Make a sketch of the areas to be surfaced with gypsum wallboard and lay out the board panels. Install the boards across (perpendicular to) the joists or studs. Use as long a board as can be handled to eliminate or reduce end joints. For example, in a 12′ × 13′ room where the ceiling joists run parallel to the 13-foot dimension, it is desirable to have the boards be 12 feet long. If they are 8 feet long, an end joint would be necessary in each course. Where end joints cannot be avoided, they should be staggered.

It is usually better to apply the board on the ceiling first, then the sidewalls.

It is often easier to use the adhesive nail-on method of application. This method results in fewer nails to drive and conceal and makes a higher-quality installation.

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2 Estimating Materials

Using your sketch, determine the lengths and number of boards required. Nails can be estimated from the chart below. About 50 percent fewer nails are required if the adhesive nail-on method is used.

Estimating Nails

Wallboard Thickness	Nail Type	Approx. lbs per 1,000 sq ft of Gypsum Wallboard
⅜", ½"	1⅝" coated-type drywall nail	5¼ lb
⅝"	1⅞" coated-type drywall nail	5¼ lb

After the wallboard is installed, the flat joints and inside corners are to be reinforced with a paper tape and joint compound. The outside corners are to be reinforced with a drywall metal corner bead and joint compound. G-P Ready-Mix is a premixed, ready-to-use product that can be used for the complete job of taping, filling, spotting, nailheads, and finishing.

(NOTE: Some installers prefer to use 1 ½" nails to the 1 ⅝", 1 ⅝" to the 1 ⅞" and 1 ⅞" for overlay work.)

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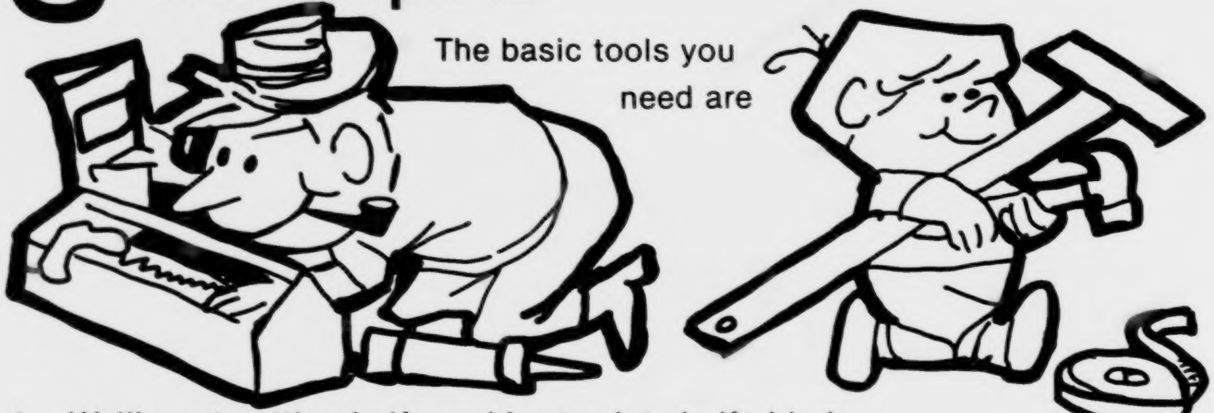
3 Tools Required



The basic tools you need are

1. Wallboard cutting knife and heavy-duty knife blade
2. Wallboard hammer
3. 4-foot T-square or steel straightedge
4. Steel tape measure
5. Utility saw or keyhole saw
6. Joint-finishing knives with 6-inch and 10-inch blades
7. Plastic pan for joint compound (use stainless for endurance)
8. Sandpaper (medium texture) for joint finishing
9. Caulking gun
10. Wallboard footlift
11. Hand sander
12. Long handled sander

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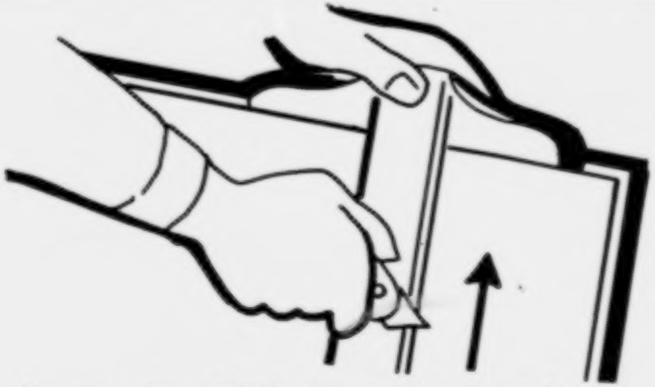
4 Cutting Gypsum Wallboard



Use T-square and wallboard knife for scoring. With the knife at right angles to the board, score completely through the face paper. Then apply firm, even pressure to snap the board. Fold back the partially separated portion of the board and use the knife again to cut the back paper. Rough edges should be smoothed. Panels can be cut with a saw if desired.

Cutting Openings

It will be necessary to cut holes in the wallboard for electrical outlets, light receptacles, etc. The distance of the opening from the top end and leading edge of the board should be carefully measured and marked from one point to another on the face of the wallboard. The opening should then be outlined in pencil and cut out with a keyhole saw. The cutout must be accurate or the cover plate will not conceal the hole.

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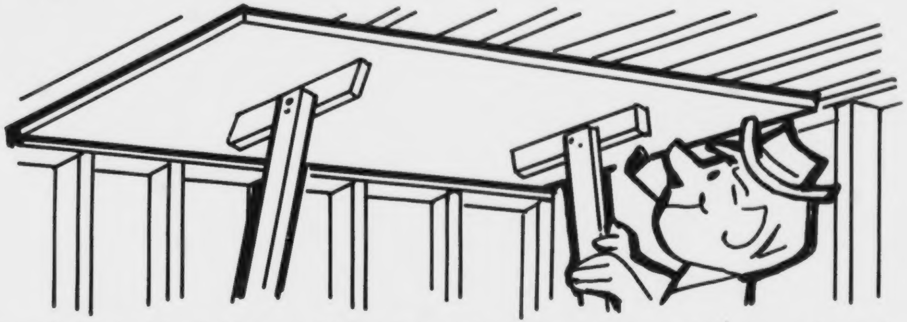
5 Ceiling Installation



It is more difficult to install the ceiling boards because of the overhead positioning. Marking of ceiling joist should be done prior to putting up the wallboard

EXAMPLE: Make a hatchet dent or a pencil mark below joist on the top plate

It is desirable to have T-braces to hold the board in place while it is being nailed. A satisfactory T-brace consists of a 2-foot piece of 1×4 nailed onto the end of a 2×4. The length should be about 1 inch longer than the floor-to-ceiling height. The nails should be 7 inches apart. When the adhesive nail-on method is used, the edges should be nailed, but place only one nail per joist in the field of the board. All edges should be supported on framing. The nails should be driven to bring the board tight to the framing, then another blow struck to dimple the nail, being careful not to break the face paper.

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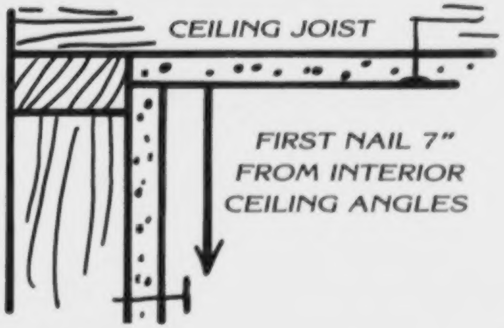
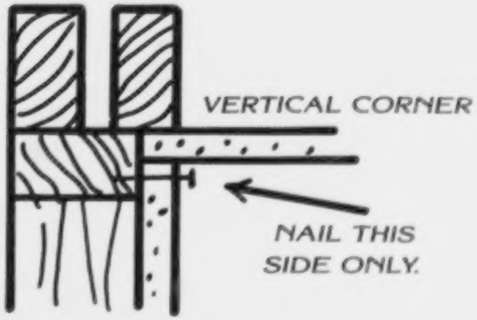
6 Wall Application





In horizontal application on sidewalls, install the top board first. Push the board up firmly against the ceiling and nail, placing nails 7 inches apart. One exception, however, is to keep all nails back 7 inches from interior ceiling angles. Nails in the interior angles are quite apt to pop. If the adhesive nail-on method is used, all of the field nailing can be eliminated. The nailing is around the edges of the board. If the board is bowed out in the center, it may be advisable to secure it with a temporary nail until the adhesive sets.

A vertical application places the long edges of the wallboard parallel to the framing members. This is more desirable if the ceiling height of your wall is greater than 8'-2" or the wall is 4 feet wide or less. Nailing recommendations are the same as for horizontal application.

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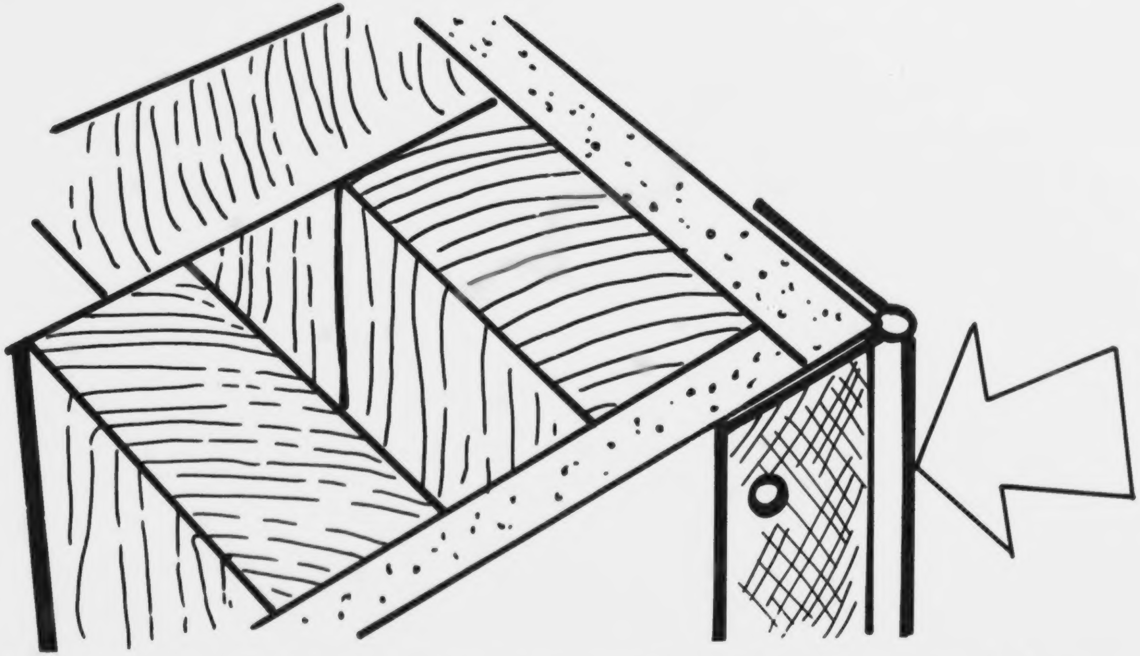
7 Metal Corner Bead



To protect corners from edge damage, install metal corner bead after you have installed the wallboard. Nail the metal corner bead every 5 inches through gypsumboard into wood framing.

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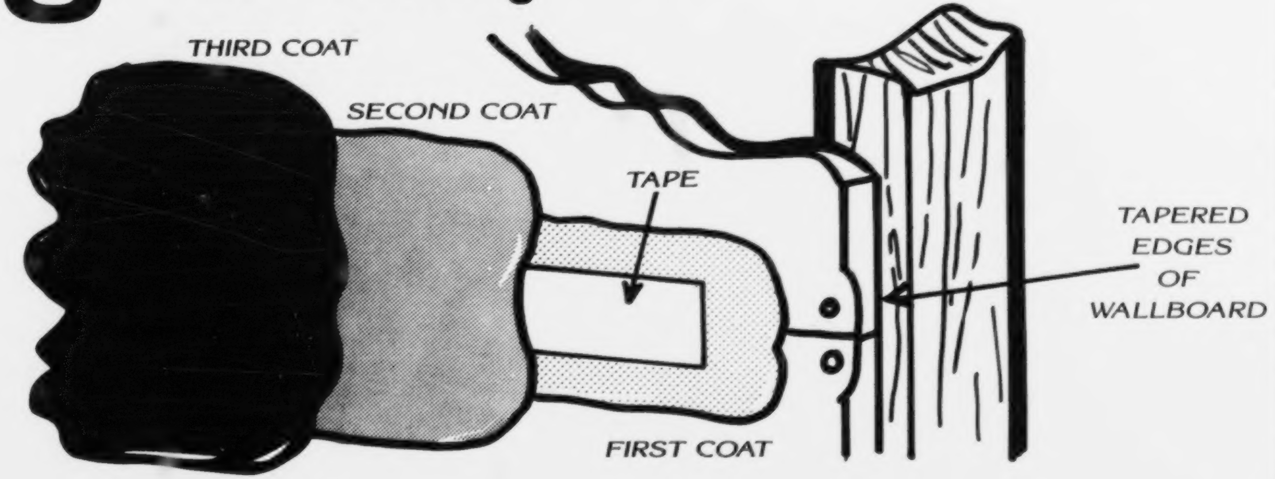
8 Joint Finishing



A premixed material such as G-P Ready-Mix joint compound is the easiest to use to finish joints, corners, and nailheads. A minimum of three coats of Ready-Mix is recommended for all taped joints. This includes an embedding coat to bond the tape and two finishing coats over the tape. Each coat should dry thoroughly, usually twenty-four hours, so that the surface can be easily sanded. When sanding, wrap your sandpaper around a wood sanding block so you sand the surface evenly. Do not over-sand or sand the paper surface. This may outline the joint or nailhead through the paint.

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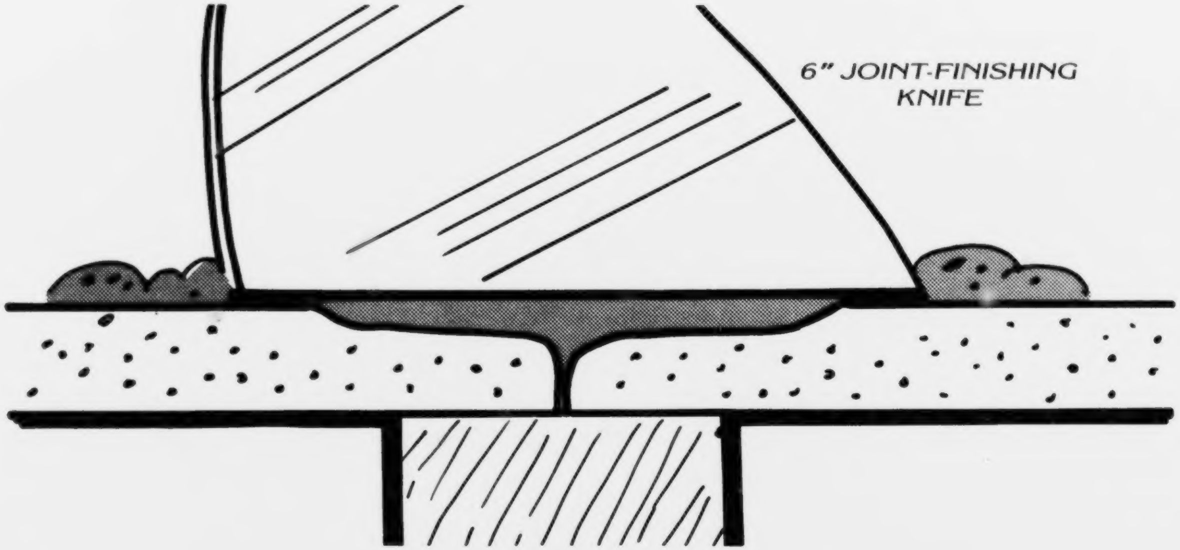
9 Applying Bedding Compound



Take your 6-inch joint-finishing knife and apply the Ready-Mix joint compound fully and evenly into the slight recess created by the adjoining edges of the board.

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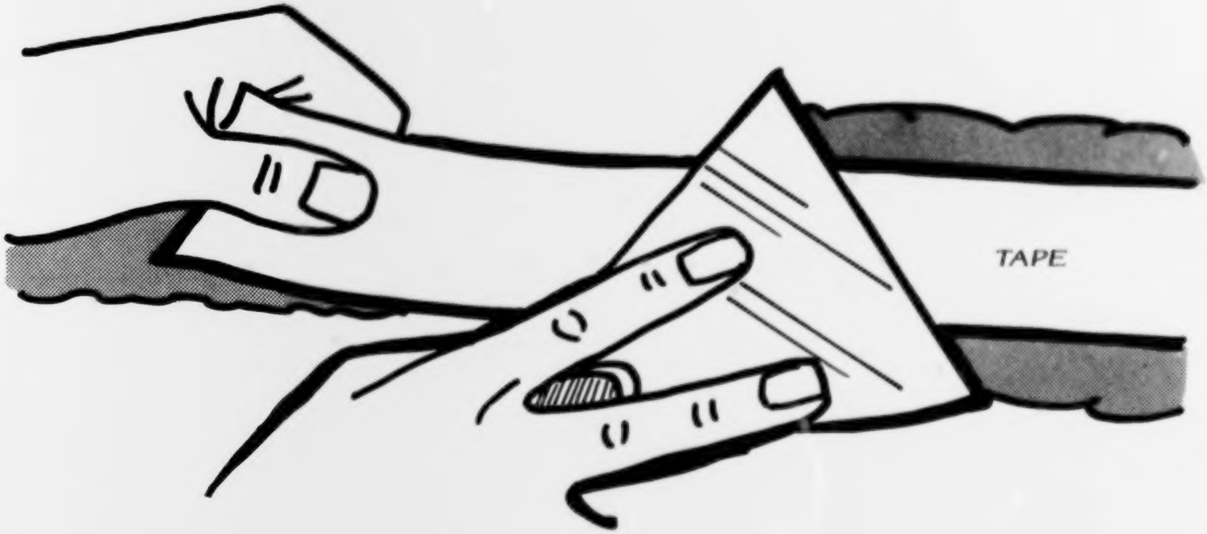
10 Applying Wallboard Tape



Next, take your wallboard tape and center it over the joint. Press the tape firmly into the bedding compound with your wallboard knife held at a 45-degree angle. The pressure should squeeze some compound from under the tape, but enough must be left for a good bond.

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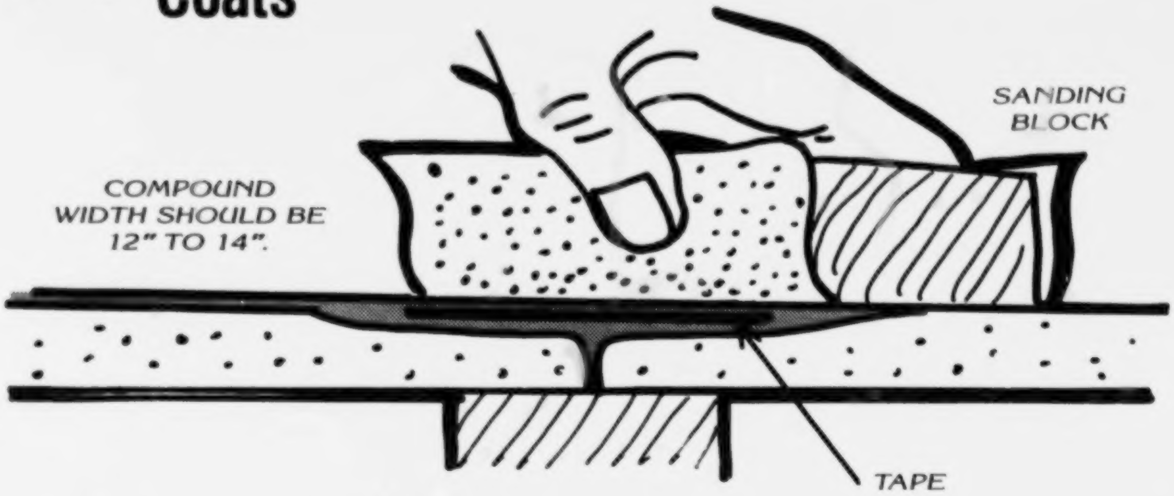
11 Applying Finishing Coats



When thoroughly dry, at least twenty-four hours, apply a fill coat extending a few inches beyond the edge of the tape, and feather the edges of the compound. When the first finishing coat is thoroughly dry, use your 10-inch joint-finishing knife to apply a second coat, and feather the edges about 1½ inches beyond the first coat. When this coat is dry, sand lightly to a smooth, even surface. Wipe off the dust in preparation for the final decoration. Total width should be 12 to 14 inches.

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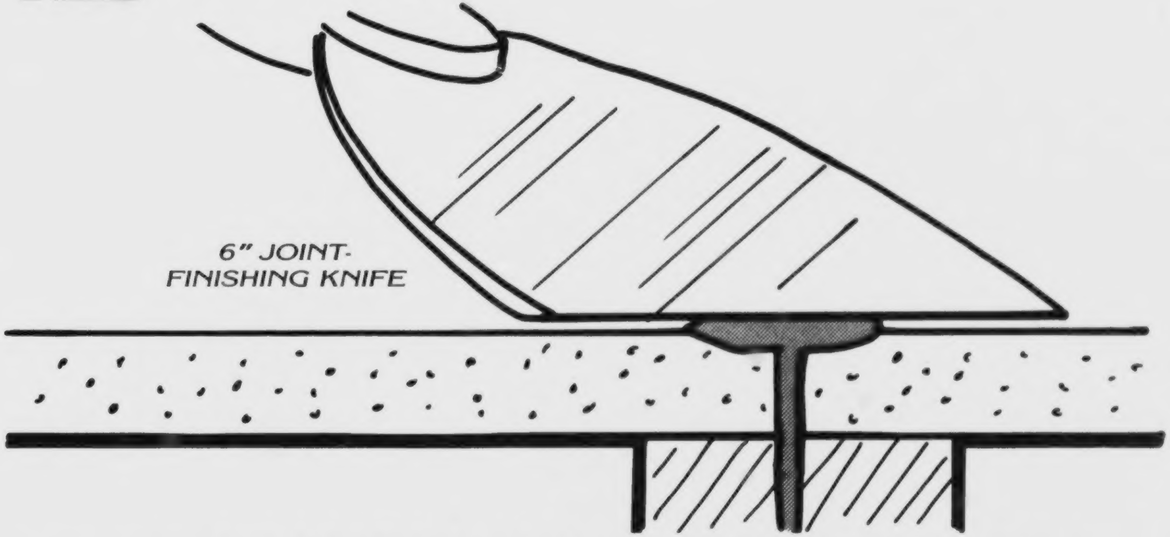
12

Finishing Nailheads



Draw your 6-inch joint-finishing knife across nails to be sure they are below the surface of the board. Apply first coat of Ready-Mix with even pressure to smooth compound level with the surface of the board. Do not bow knife blade with excess pressure as this tends to scoop compound from dimpled area. When dry, apply second coat; let dry; sand lightly, and apply third coat. Sand lightly before applying your decoration. An additional coat may be needed, depending on temperature and humidity.

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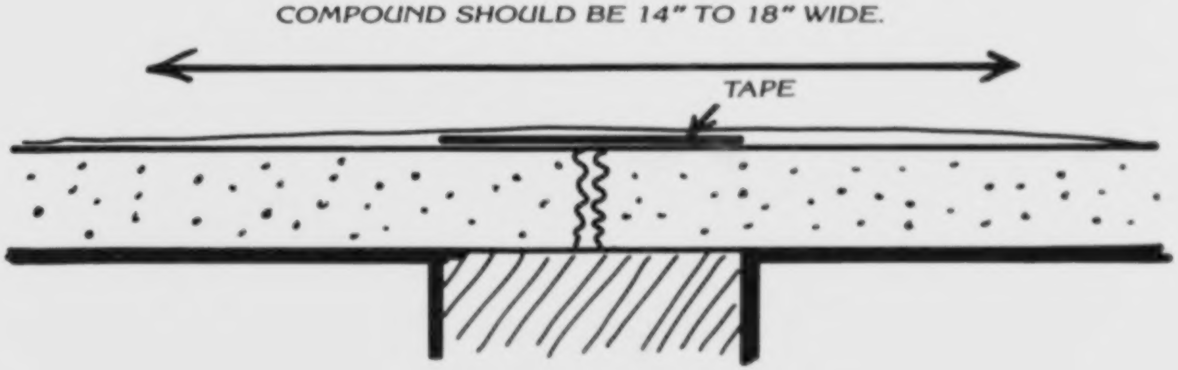
13 Finishing End Joints



You use basically the same steps with end or butt joints as you do with tapered edges. The end joints are not tapered, so care must be taken not to build up the compound in the center of the joint. This encourages ridging and shadowed areas. Feather the compound well out on each side of the joint. Final application of joint compound should be 14 to 18 inches wide.

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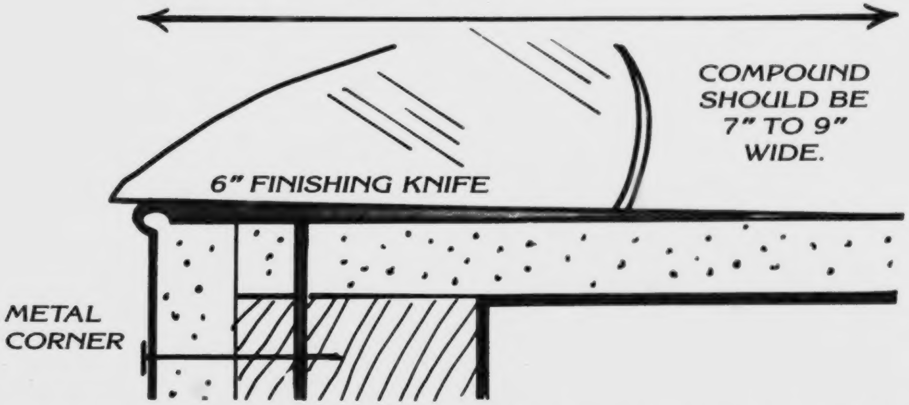
14 Finishing Metal Corner Bead



Be sure the metal corner is attached firmly. Take your 6-inch finishing knife and spread the G-P Ready-Mix 3 to 6 inches wide from the nose of the bead, covering the metal edges. When completely dry, sand lightly and apply second coat, feathering edges 2 to 3 inches beyond the first coat. A third coat may be needed, depending on your coverage. Feather the edges of each coat 2 or 3 inches beyond the preceding coat.

(NOTE: Window and door returns are made in a similar manner as the metal corners; but more accuracy should be maintained when cutting and installing the returns.)

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DRYWALL
UNIT II

INFORMATION SHEET

I. Terms and definitions associated with drywall

   A. Drywall — Any rigid sheathing material applied to interior finish walls and ceilings

   B. Wallboard — Rigid sheathing material made with a noncombustible core (usually gypsum) that is surfaced with treated paper or some other sheet material; sheathing material applied to interior finish walls and ceilings

   C. Backing — Strips of wood nailed on top of top plate between joists and at inside wall angles of partitions; provides a solid base for nailing wallboard

   D. Joint — Place where edges of two pieces of wallboard meet

   E. Perforated tape — Paper tape used as reinforcement at wallboard joints to keep surface from cracking

   (NOTE: Perforated tape comes in rolls that are 2 inches wide and 60, 250, or 500 feet long.)

   F. Bedding — Joint compound applied to depression formed by butt joints and tapered wallboard edges

   G. Joint compound — Compound used to embed perforated tape to wallboard joints, to finish over tape and corner bead, and to finish over nail or screw heads

   H. Topping — Finish coat of compound that covers all previous coats

   I. Quick-weld compound — Compound specially blended to set in from 20 to 90 minutes; is used almost exclusively in constructing manufactured housing

   J. Featheredge — To spread joint compound or topping so that it tapers to a thin edge

   K. Dimple — Impression on wallboard surface formed by a nail driven to proper depth

   L. Double nailing — Pattern used when two nails are spaced 2 inches apart every 12 inches; pattern used on intermediate joists and studs

   M. Laminate — To make by uniting two or more layers of material

II. Types of gypsum wallboard

   A. Regular

   (NOTE: Regular wallboard is the most commonly used gypsum wallboard.)

INFORMATION SHEET

B. Type "X"

(NOTE: Type "X" gypsum wallboard has a harder core than the regular type of wallboard.)

C. Insulating

(NOTE: Insulating gypsum wallboard, as the name implies, has insulation mixed into the core.)

D. Backing board

(NOTE: Backing-board gypsum wallboard does not have a finished surface; therefore, it is used where it will be covered with a finished material, such as paneling.)

E. Core board

(NOTE: Core-board gypsum wallboard is 1 inch thick and is made up of wood filler and gypsum. It is sometimes used as subflooring.)

F. Fire code

(NOTE: Fire-code gypsum wallboard has a surface coating that prevents the spread of fires.)

G. Waterproof

(NOTE: Waterproof gypsum wallboard is recognized by its green or blue color; it is used in bathrooms and other areas that are exposed to moisture.)

H. Predecorated

(NOTE: Predecorated wallboard is available in a variety of surface materials, designs, and patterns; it is usually installed vertically because of the difficulty in matching and finishing the butt joints.)

III. Standard sizes of gypsum wallboard

(NOTE: Wallboard can be special ordered to specific sizes. Being able to buy wallboard in different sizes reduces building costs substantially.)

A. Standard thicknesses

(NOTE: The 1/2-inch and 5/8-inch thicknesses are the most commonly used sizes.)

1. 1/4 inch
2. 3/8 inch
3. 1/2 inch
4. 5/8 inch
5. 1 inch

INFORMATION SHEET

B. Standard width — 4 feet

(NOTE: All gypsum wallboard comes in 4-foot widths.)

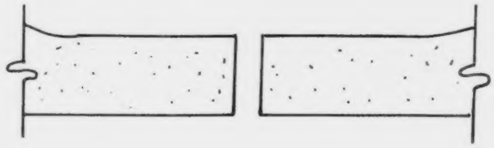
C. Standard lengths

1. 4 feet
2. 6 feet
3. 8 feet
4. 10 feet
5. 12 feet
6. 16 feet

IV. Standard edge shapes of gypsum wallboard (Figures 1-5)

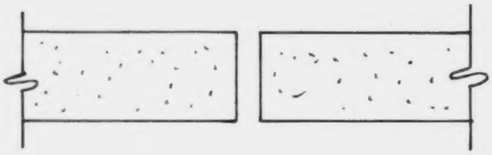
A. Tapered

FIGURE 1



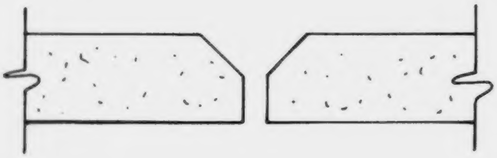
B. Square

FIGURE 2



C. Beveled

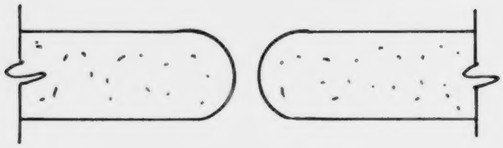
FIGURE 3



INFORMATION SHEET

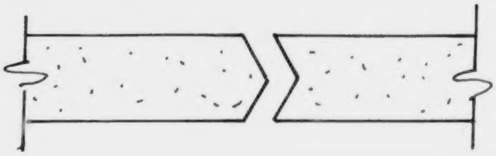
D. Round

FIGURE 4



E. Tongue and groove (T & G)

FIGURE 5



V. Benefits of using gypsum wallboard

   A. Is easily applied

   B. Is economical

   C. Is easily maintained

   D. Is easily repaired

   E. Is noncombustible

   F. Provides a good base for applying finish materials

VI. Types of base or construction where wallboard is used

   A. Single layer applied to wood framework

   B. Single layer applied to metal framework

   C. Single layer applied directly to masonry walls

   D. Single layer applied to wood or metal furring strips

   E. Single layer used as subflooring

   (NOTE: Core board is used as subflooring.)

   F. Double layer (two-ply overlay) nailed, screwed, or laminated to base layer

INFORMATION SHEET

VII. Hardware and fasteners used with gypsum wallboard

A. Hardware

1. Metal corner bead (Figures 6 and 7)

FIGURE 6

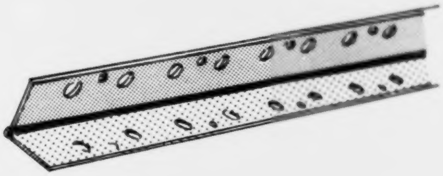
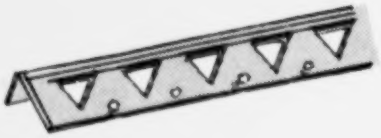


FIGURE 7



2. Metal casing bead (Figures 8-10)

FIGURE 8

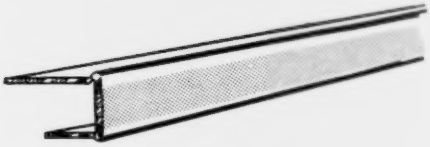


FIGURE 9

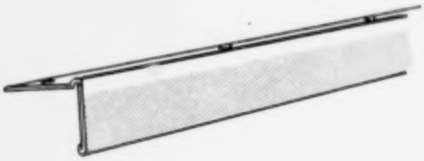
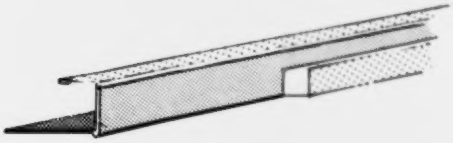


FIGURE 10



3. Flex-tape corner (Figures 11 and 12)

FIGURE 11: Flex-tape on roll

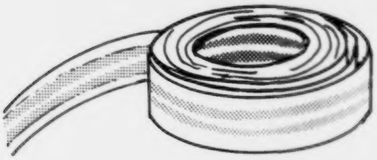
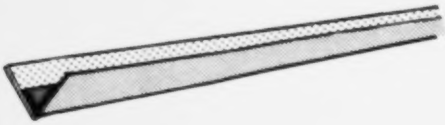


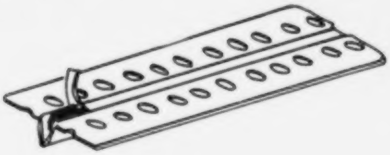
FIGURE 12: Flex-tape shaped into a corner



INFORMATION SHEET

4. Expansion joint (Figure 13)

FIGURE 13

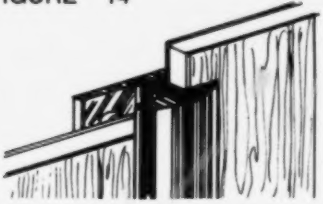


5. Molding for predecorated wallboard (Figures 14-17)

(NOTE: Molding generally matches the colors or patterns used in the predecorated wallboard, which is applied to the wall with adhesive or colored nails.)

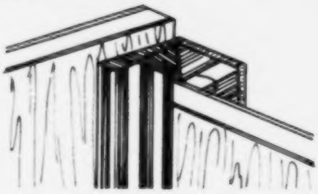
a. Divider

FIGURE 14



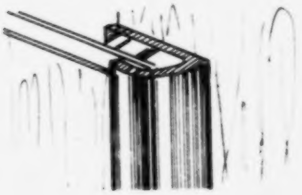
b. Inside corner

FIGURE 15



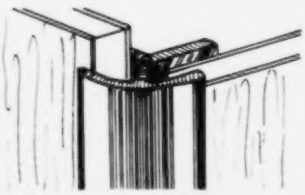
c. End cap

FIGURE 16



d. Outside corner

FIGURE 17

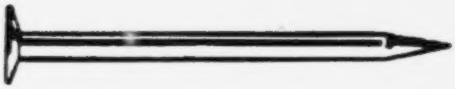


B. Fasteners

(NOTE: Drywall nails, screws, and staples may be purchased in a variety of sizes and lengths.)

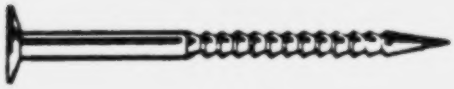
1. Coated nail (Figure 18)

FIGURE 18



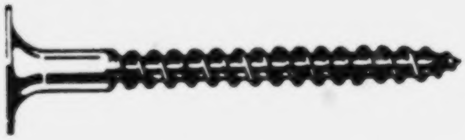
2. Annular-ring nail (Figure 19)

FIGURE 19



3. Phillips-head screw (Figure 20)

FIGURE 20



4. Staple (Figures 21 and 22)

FIGURE 21

FIGURE 22

VIII. Types of finishes that may be applied to gypsum wallboard

A. Paint

B. Wallpaper

C. Texture

D. Paneling

E. Ceramic tile

F. Acoustical tile

G. Predecorated finishes

(NOTE: Predecorated finishes are applied by the manufacturer.)

IX. Estimating materials needed to dry wall a structure

(NOTE: Gypsum wallboard is estimated in square feet figured to the nearest 6 inches.)

A. Determine total square footage to be covered with wallboard

INFORMATION SHEET

1. Check plans and compute square footage of floor space in structure

2. Multiply square footage of floor space times 3.625 ($3^5/_8$) and round up to the nearest square foot to find total square footage of ceilings and walls to be covered with wallboard

   (NOTE: The number 3.625 [$3^5/_8$] is a constant that represents the square feet of flat ceiling and 8-foot walls for each square foot of floor.)

   EXAMPLE: If the square footage of floor space of a structure is 1,206 square feet, then

   1,206 sq ft × 3.625 = 4,371.75 sq ft = 4,372 total sq ft to be covered with wallboard

B. Determine number of sheets of each size of wallboard needed

(NOTE: Estimators like to order three-fourths of the total amount of wallboard needed in 12-foot sheets and one-fourth in 8-foot sheets. Also, wallboard is generally applied at right angles to ceiling joists and horizontally to walls. To reduce joint treatment and cracking, vertical joints are placed over door and window openings at least 6 inches from the end of the header.)

1. Check plans and compute square footage of special wallboard needed

2. Compute number of 4′ × 12′ sheets needed

   a. Multiply total square footage to be covered by wallboard times $^3/_4$ to find square footage to be covered by 4′ × 12′ sheets

      EXAMPLE: If there are 4,372 square feet to be covered by wallboard, then

      4,372 sq ft × $^3/_4$ = 3,279 sq ft = 3,279 sq ft to be covered by 4′ × 12′ sheets

   b. Divide square footage to be covered by 4′ × 12′ sheets by 48 to find number of 4′ × 12′ sheets needed

      (NOTE: Forty-eight is the number of square feet in each 4′ × 12′ sheet of wallboard.)

      EXAMPLE: If there are 3,279 square feet to be covered by 4′ × 12′ sheets, then

      3,279 sq ft ÷ 48 sq ft = 68.31 sheets = 68 sheets needed

INFORMATION SHEET

3. Compute number of 4′ × 8′ sheets needed

   a. Subtract square footage to be covered by 4′ × 12′ sheets from total square footage to be covered by wallboard to find square footage to be covered by 4′ × 8′ sheets

      EXAMPLE: If there are 4,372 square feet to be covered with wallboard and 3,279 square feet to be covered by 4′ × 12′ sheets, then

      4,372 sq ft − 3,279 sq ft = 1,093 sq ft to be covered by 4′ × 8′ sheets

   b. Divide total square footage to be covered by 4′ × 8′ sheets by 32 to find number of 4′ × 8′ sheets needed

      (NOTE: Thirty-two is the number of square feet in each 4′ × 8′ sheet of wallboard.)

      EXAMPLE: If there are 1,093 square feet to be covered by 4′ × 8′ sheets, then

      1,093 sq ft ÷ 32 sq ft = 34.15 sheets = 34 sheets needed

C. Determine amount of fastening and finishing materials needed

1. Use Table 1 to find the amount of nails, screws, joint compound, tape, and texture paint needed per 1,000 square feet of wallboard

   (NOTE: Nail spacing should be a minimum of 7 inches on ceilings and 8 inches on walls; however, when double nailing is used, nails are spaced 2 inches apart every 12 inches.)

TABLE 1: Fastening and Finishing Materials Required for 1,000 Square Feet of Wallboard

Material	Amount
1¼″ annular-ring nail	6¼ lb
1⅜″ annular-ring nail	6¾ lb
1″ drywall screw	3 lb
1¼″ drywall screw	4¼ lb
1⅝″ drywall screw	5½ lb
Ready-mix joint compound	80 lb (50-lb container)
Dry joint compound	50 lb (25-lb bag)
Perforated tape	370 lin ft
Texture paint	10 lb to 50 lb (25-lb bags)

INFORMATION SHEET

EXAMPLE: If a structure has 4,048 square feet to be covered with wallboard and fastened with 1¼-inch annular-ring nails, then

6¼ lb × 4 = 25 lb of annular-ring nails needed

2. Check manufacturer's recommendations to find the amount of adhesive needed for the type of adhesive you are using

   (NOTE: Each type of wallboard adhesive has a different coverage capability; therefore, always follow the manufacturer's recommendation.)

3. Check plans and count the number of outside metal corners needed

DRYWALL
UNIT II

ASSIGNMENT SHEET #1 — ESTIMATE DRYWALL MATERIALS FOR A ROOM

NAME ______________________________ SCORE ______________

The use of wallboard is a great convenience to the carpenter. It saves a great deal of time and money over constructing walls and ceilings from lath and plaster. However, these savings can be quickly lost if materials are poorly estimated. Estimates need to be accurate to avoid unnecessary handling of wallboard or delays due to ordering too little material. This assignment will help you become proficient in estimating drywall materials.

Using Information Sheet, Section IX, estimate the amounts of the following materials needed to dry wall the room illustrated on the following page. Show your work in the space provided at the bottom of this page. Write the correct answers in the blanks.

A. Square feet of gypsum wallboard needed to cover walls and ceiling = ______________

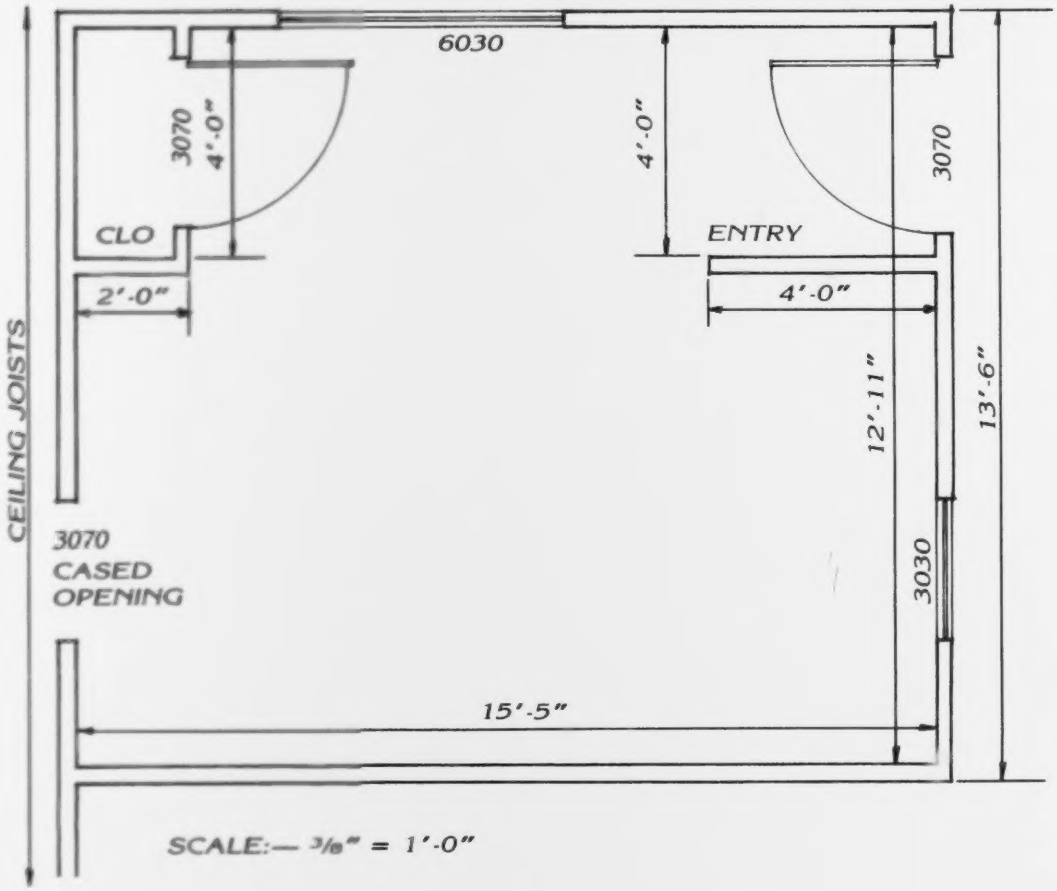
B. Pounds of 1¼-inch annular-ring nails needed = ______________________

C. Feet of perforated tape needed = ______________________________

D. Pounds of ready-mix joint compound needed = ______________________

E. Number of outside metal corners needed = ________________________

ASSIGNMENT SHEET #1


6030
3070
4'-0"
CLO
2'-0"
4'-0"
ENTRY
3070
4'-0"
12'-11"
13'-6"
CEILING JOISTS
3070
CASED
OPENING
3030
15'-5"
SCALE:— 3/8" = 1'-0"

(NOTE: Ceiling height is 8' –0".)

DRYWALL
UNIT II

ASSIGNMENT SHEET #2 — ESTIMATE DRYWALL MATERIALS FOR AN OFFICE BUILDING

NAME ____ SCORE ______________

The key to accurate estimating of drywall materials is in determining the square footage of the area to be finished. Generally, the carpenter will base estimates on sections of a building to reduce the variation in numbers of interior walls and other factors. This assignment will help you to become able to figure accurate estimates.

PART I

Calculate the total square feet of walls and ceilings (10' high) for the individual offices in the structure illustrated on the next page. Show your work in the space provided below and write the correct answers in the blanks.

A. Office #1 = ____

B. Stock room and restroom = ______________________________

C. Office #2 = ____

D. Stock room = ____

E. Office #3 = ____

F. Stock room and restroom = ______________________________

G. Utility room and restroom for Office #2 = ________________

ASSIGNMENT SHEET #2

PART II

Using the Information Sheet, Section IX, estimate the amounts of the following materials needed to apply and finish wallboard for the structure illustrated on the preceding page. Show your work in the space below and write the correct answers in the blanks.

A. Total square feet = ____________________

B. Total square feet of drywall needed = ____________________

C. Pounds of 1¼-inch annular-ring nails = ____________________

D. Feet of perforated joint tape needed = ____________________

E. Pounds of ready-mix joint compound needed = ____________________

F. Number of outside metal corners needed = ____________________

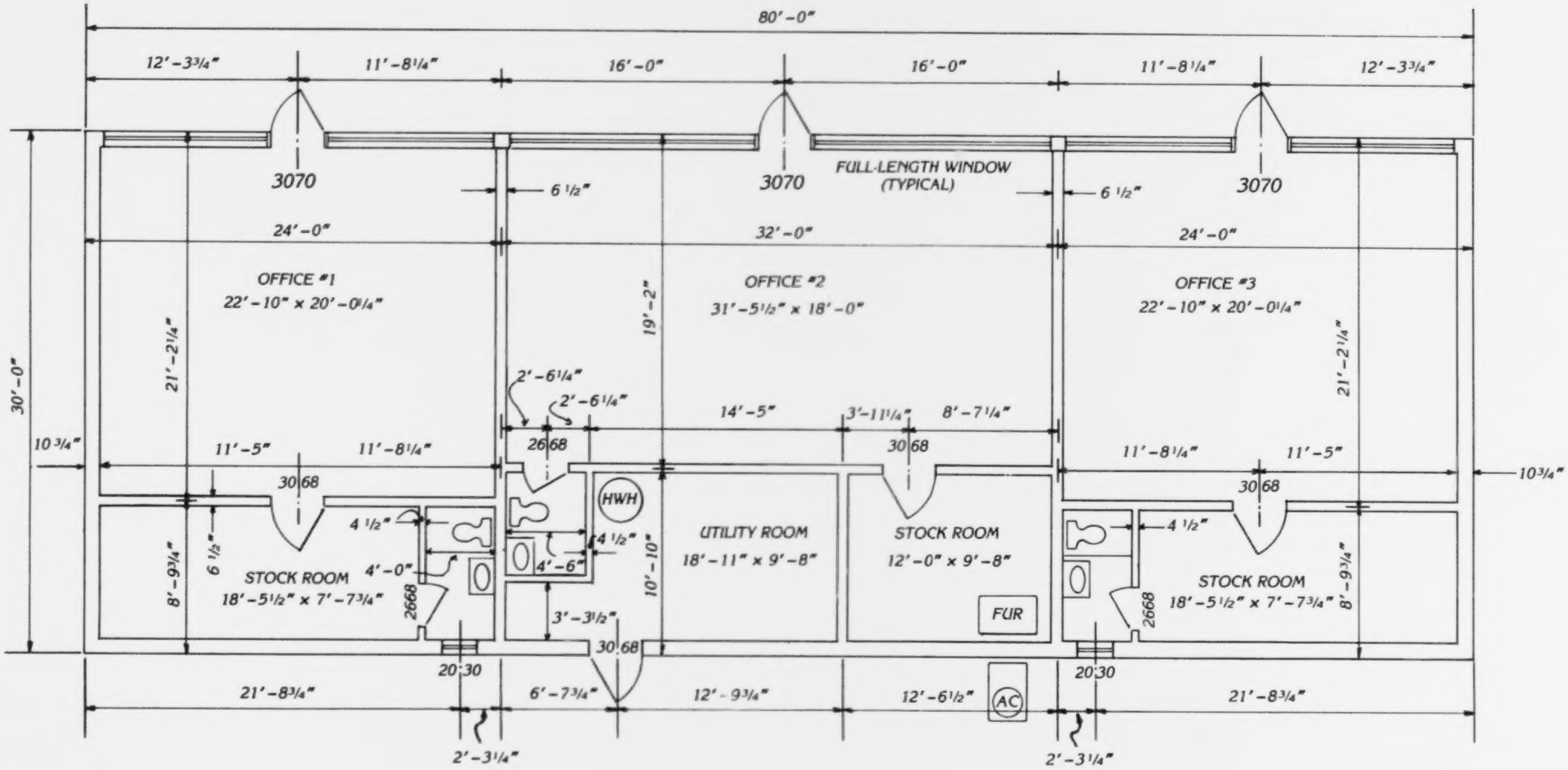
PART III

Use your estimate of the total square footage of drywall required to determine the number of pieces of each size of drywall required. Assume that three-fourths of the material should be 4′ × 12′ × ½″ and the remainder 4′ × 8′ × ½″. How much of each size is required? Show your work in the space below and write the correct answers in the blanks.

A. 4′ × 12′ = ____________________ sheets

B. 4′ × 8′ = ____________________ sheets

ASSIGNMENT SHEET #2


80'-0"
12'-3 3/4"
11'-8 1/4"
16'-0"
16'-0"
11'-8 1/4"
12'-3 3/4"
3070
3070
3070
FULL-LENGTH WINDOW (TYPICAL)
6 1/2"
6 1/2"
24'-0"
32'-0"
24'-0"
30'-0"
OFFICE #1
22'-10" × 20'-0 1/4"
OFFICE #2
31'-5 1/2" × 18'-0"
OFFICE #3
22'-10" × 20'-0 1/4"
21'-2 1/4"
19'-2"
21'-2 1/4"
2'-6 1/4"
2'-6 1/4"
14'-5"
3'-11 1/4"
8'-7 1/4"
10 3/4"
11'-5"
11'-8 1/4"
26 68
30 68
11'-8 1/4"
11'-5"
10 3/4"
30 68
30 68
HWH
4 1/2"
4 1/2"
4 1/2"
4'-0"
4'-6"
6 1/2"
8'-9 3/4"
STOCK ROOM
18'-5 1/2" × 7'-7 3/4"
2668
UTILITY ROOM
18'-11" × 9'-8"
10'-10"
STOCK ROOM
12'-0" × 9'-8"
FUR
STOCK ROOM
18'-5 1/2" × 7'-7 3/4"
2668
8'-9 3/4"
3'-3 1/2"
30 68
20 30
20 30
21'-8 3/4"
6'-7 3/4"
12'-9 3/4"
12'-6 1/2"
AC
21'-8 3/4"
2'-3 1/4"
2'-3 1/4"

FLOOR PLAN FOR OFFICE BUILDING

SCALE: 1/8" = 1'-0"

DRYWALL
UNIT II

ANSWERS TO ASSIGNMENT SHEETS

(NOTE: These answers are only a reference guide. Due to variations in rounding and procedures, these assignment sheets must be evaluated to the satisfaction of the instructor.)

Assignment Sheet #1

A. 820

B. 5.12 or 5

C. 303

D. 66 (2 containers)

E. 3

Assignment Sheet #2

PART I

A. 1090 square feet

B. 964 square feet

C. 1,247 square feet

D. 560 square feet

E. 1090 square feet

F. 964 square feet

G. 1000 square feet

PART II

A. 6,915

B. 6,915

C. 44

D. 2,590

E. 560 (12 containers)

F. 1

PART III

A. 108

B. 54

DRYWALL
UNIT II

JOB SHEET #1 — INSTALL GYPSUM WALLBOARD

I. Tools and materials

A. Tools

1. Drywall hatchet
2. Folding rule or steel tape
3. Nail pouch
4. Utility knife
5. Drywall square
6. Drywall saw
7. Wallboard jacks
8. Circle cutter
9. Drywall keyhole saw
10. Surform tool

B. Materials

1. Gypsum wallboard
2. Nails
3. Metal corners
4. 2×4s for ceiling Ts

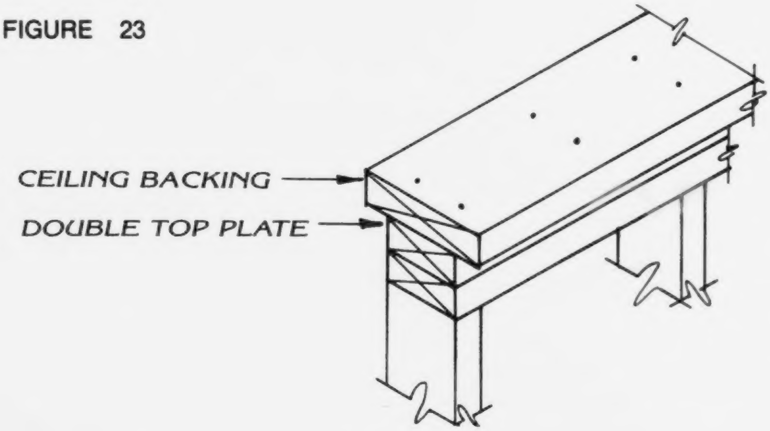
II. Procedure for ceiling installation

(NOTE: Ceiling wallboard should always be applied first, but before any wallboard is applied, be sure that electrical, water, gas, heating, and air-conditioning rough-in has been completed, that the inspection has been completed and approved, and that the exterior wall insulation has been installed.)

A. Preparing for installation

1. Install backing along top plate if it has not already been installed (Figure 23)

FIGURE 23



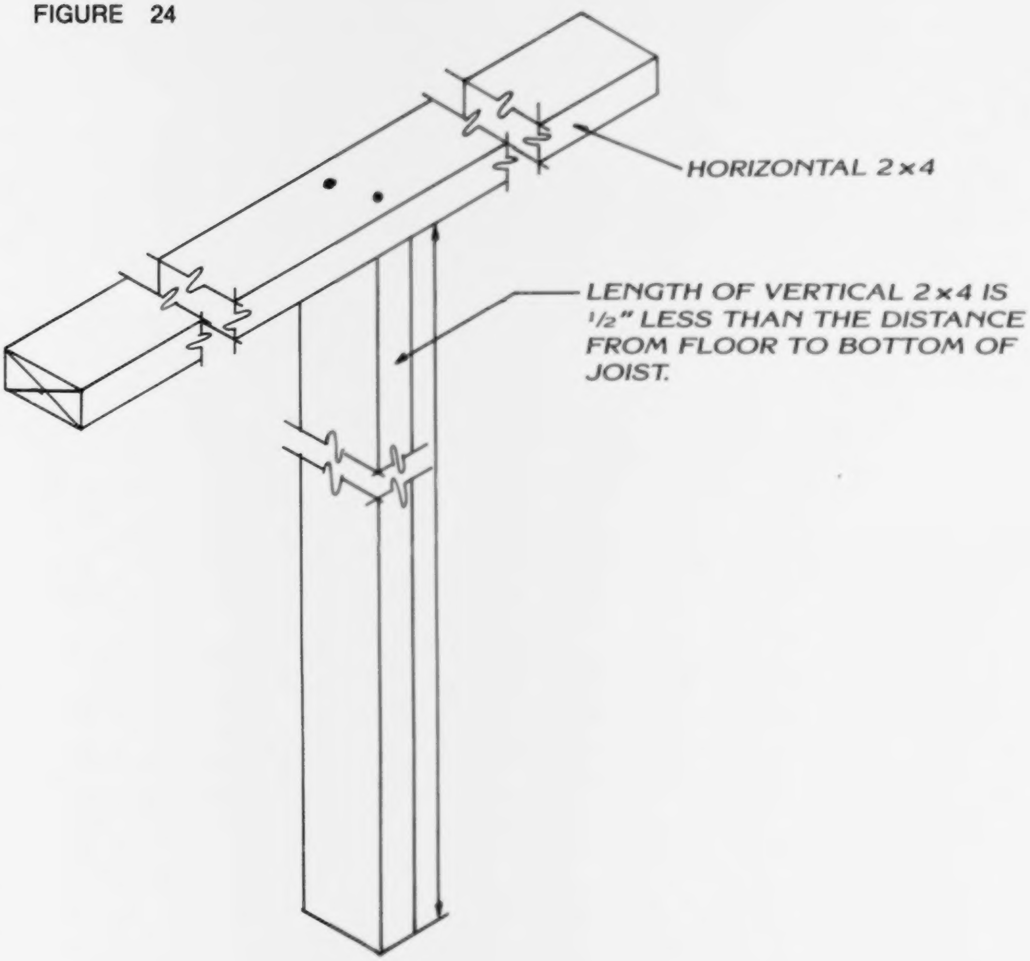
/

JOB SHEET #1

2. Construct two or more ceiling Ts from 2×4s, making the vertical member $1/2$-inch shorter than the distance from the floor to the bottom of the joist (Figure 24)

   (NOTE: Ceiling Ts are used to support the ceiling wallboard during nailing.)

FIGURE 24

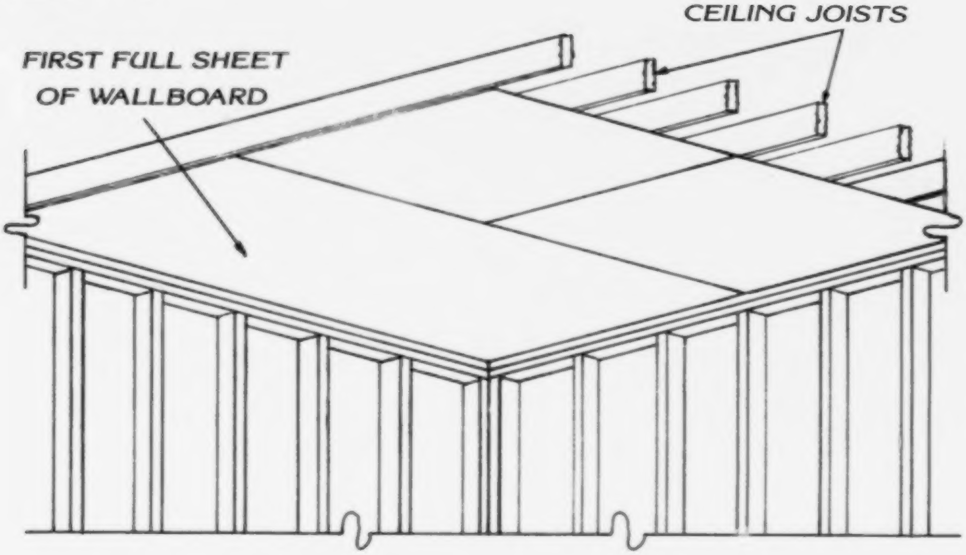

HORIZONTAL 2×4
LENGTH OF VERTICAL 2×4 IS 1/2" LESS THAN THE DISTANCE FROM FLOOR TO BOTTOM OF JOIST.

B. Installing first full sheet of ceiling wallboard

   1. Beginning in a corner, position full sheet of wallboard at right angle to ceiling joists (See Figure 25)

JOB SHEET #1

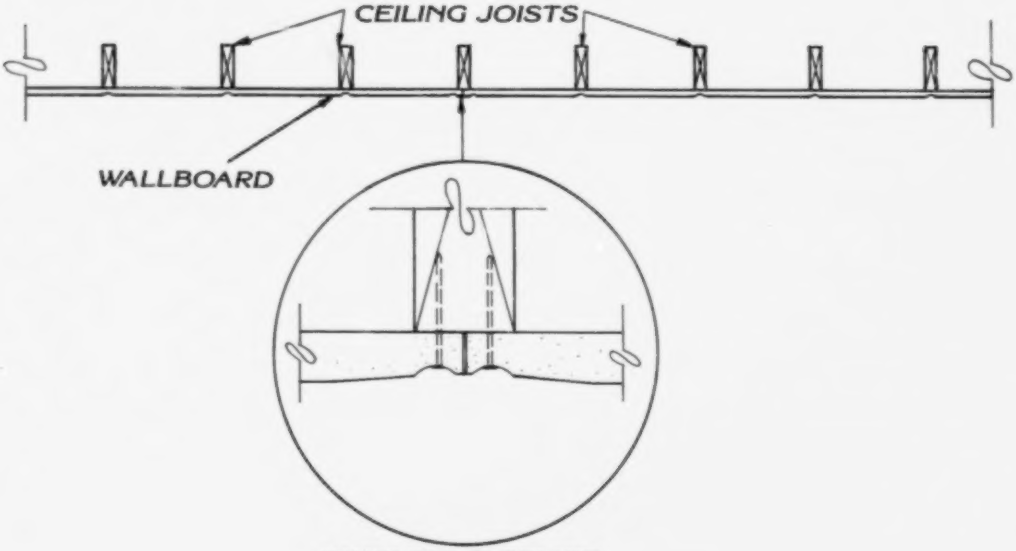
FIGURE 25


CEILING JOISTS
FIRST FULL SHEET OF WALLBOARD

2. Position ceiling Ts to support wallboard sheet and to hold it in place
3. Beginning at center of sheet and working outward, nail wallboard by driving nails flush and then striking once more to make a dimple (Figure 26)

(NOTE: Do not break the surface paper when nailing.)

FIGURE 26


CEILING JOISTS
WALLBOARD

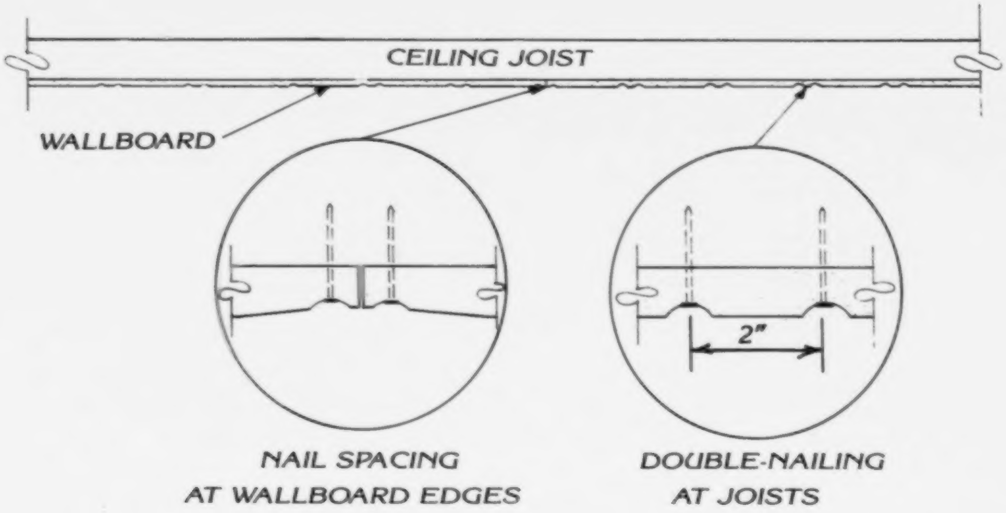
DIMPLES AT SPLICE

JOB SHEET #1

4. Double-nail sheet along joists by placing two nails 2 inches apart at 12-inch intervals (See Figure 27)

5. Nail one nail every 7 inches along wallboard edges (Figure 27)

FIGURE 27



C. Cutting and installing remaining ceiling wallboard

1. Measure ceiling and then subtract 1/8 inch from measured length

   (NOTE: Breaks must fall on joist or nail backing.)

2. Mark measurements on finished face of wallboard
3. Hold straightedge on marks and use sharp knife to cut through face paper
4. Break wallboard at cut
5. Use knife to cut paper on back side of wallboard
6. Use surform tool to smooth cut edge if necessary
7. Nail wallboard following procedures in steps B-2 through B-5 for installing first full sheet

D. Cutting openings for electrical boxes, switches, etc.

(NOTE: Openings should be no more than 1/8 inch larger than fixture.)

JOB SHEET #1

    1. Measure distance of opening from the end and edge of wallboard
    2. Mark measurement on face of wallboard
    3. Outline opening with pencil
    4. Cut out opening with keyhole saw

III. Procedure for wall installation

  A. Installing first full sheet of wallboard in top row

    1. Beginning in a corner, hold full sheet of wallboard tightly against ceiling wallboard
    2. Beginning at center of sheet and working outward, nail wallboard by driving nails flush and then striking once more to make a dimple
    3. Double-nail sheet along joists by placing two nails 2 inches apart at 12-inch intervals
    4. Nail one nail every 8 inches along wallboard edges

  B. Cutting and installing remaining wallboard in top row

  (NOTE: Whenever possible, wallboard should be installed horizontally on walls. Plan installation so that vertical joints are above door and window openings whenever practical. See Figure 28. Also, joints should be at least 6 inches from end of headers to reduce cracking and joint treatment.)

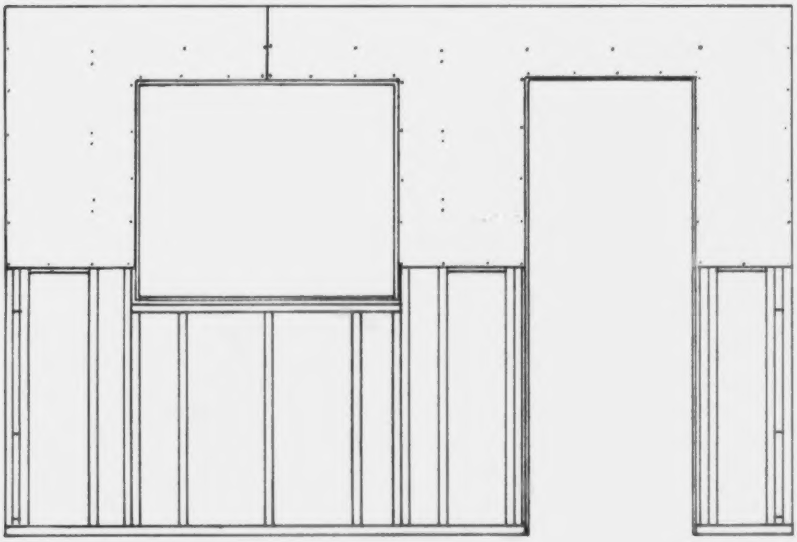
    1. Measure wall and then subtract $^1/_8$ inch from measured length
    2. Mark measurements on finished face of wallboard

       (NOTE: Wallboard over door and window openings may be put in position and cut in place.)

    3. Hold straightedge on marks and use a sharp knife to cut through face paper
    4. Break wallboard at cut
    5. Use knife to cut paper on back side of wallboard
    6. Use surform tool to smooth cut edge if necessary
    7. Nail wallboard following procedures in steps A-2 through A-4 for installing first full sheet (See Figure 28)

JOB SHEET #1

FIGURE 28

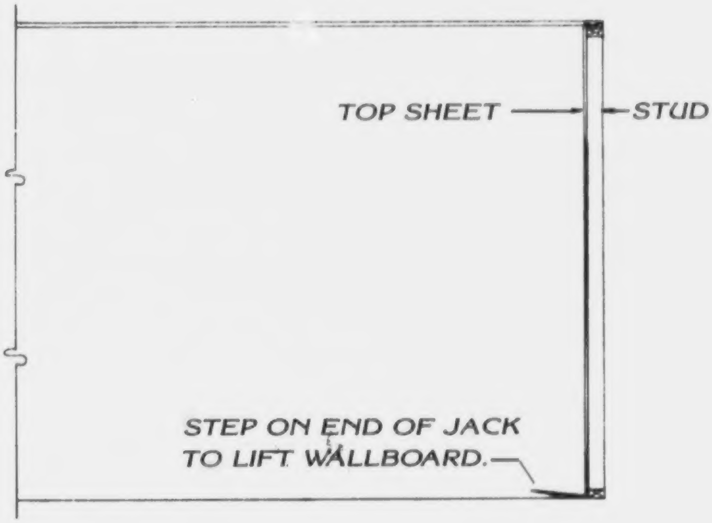


C. Cutting and installing wallboard in bottom row

1. Measure wall, mark measurements on wallboard, and cut wallboard, following steps B-1 through B-6

2. Position wallboard with wallboard jacks to lift and hold sheet tight against sheet in top row

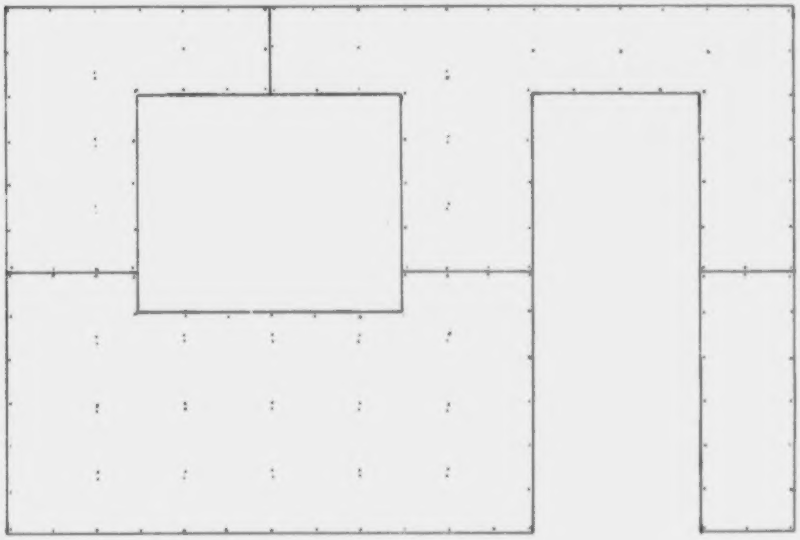
FIGURE 29


TOP SHEET
STUD
STEP ON END OF JACK TO LIFT WALLBOARD.

JOB SHEET #1

3. Nail wallboard following procedures in steps A-2 through A-4 for installing first full sheet
4. Continue cutting and installing as required to complete wallboard installation (Figure 30)

FIGURE 30



IV. Procedure for installing metal corner beads

(NOTE: Metal corner beads are used only on outside corners.)

A. Measure length of outside corner

B. Cut metal corner bead to length if necessary

C. Position metal corner bead over outside corner and nail corner bead every 5 inches on both edges through wallboard into wood frame

D. Clean up area and put away tools and equipment

DRYWALL
UNIT II

JOB SHEET #2 — FINISH WALLBOARD JOINTS AND DEPRESSIONS

I. Tools and equipment

  A. Drywall hammer or hatchet

  B. Taping knife

  C. 4-inch and 10-inch finishing knives

  D. Mud pan

  E. Joint tape

  F. Joint compound

  G. Corner beads (when appropriate)

  H. Nails for corner beads

  I. Sander and sandpaper

II. Procedure

  A. Prepare walls for bedding and taping

    1. Install all corner beads, nailing every 5 inches through the drywall and into the framing

    2. Make a quick check to be sure all nails are set with proper dimples; correct as necessary

  B. Bed and tape joints

    1. Straight joints

      a. Fill with joint compound channel formed by tapered edges of drywall sheets

      b. Center tape directly over joint and embed tape by pressing it firmly into compound with knife

      c. Smooth compound around and over tape to form level surface

      (NOTE: Some compound should be squeezed from under the tape, but leave enough to form a good bond.)

JOB SHEET #2

2. Inside-corner joints

    a. Fold joint tape down the middle

    b. Apply compound to both sides of corner

    c. Press creased tape into corner with knife

    d. Smooth out compound on both sides of corner

C. Fill nail depressions

1. Apply compound

2. Draw knife across dimple with an even, smooth pressure

3. Turn knife at a right angle to first application and draw it back across depression to smooth compound level with surface of drywall

D. Apply compound over bead flange of corner beads and out from the bead 4 to 6 inches

E. Finish joints, nail depressions, and corner beads

1. After drying at least twenty-four hours, lightly sand all areas where compound was applied

    (NOTE: Do not damage the face of the drywall.)

2. Apply thin coat of compound over all areas previously coated, feathering out edges 1½ to 3 inches beyond edges of first coat

3. Let compound dry for at least twenty-four hours, and then sand lightly

4. Apply another coat of compound over all areas previously coated, feathering out edges to a total width of 14 to 18 inches

5. Let compound dry for at least twenty-four hours, and then sand lightly

    (NOTE: Conditions such as temperature and humidity may make it necessary to apply additional coats for a smooth surface. Follow the procedures in steps 4 and 5 if additional coats are required.)

6. Clean up area and put away tools and equipment

DRYWALL
UNIT II

JOB SHEET #3 — APPLY LAMINATED GYPSUM WALLBOARD

I. Tools and materials

   A. Tools

      1. Drywall hammer
      2. Utility knife
      3. Carrier lifter
      4. Drywall lifter
      5. Drywall and keyhole saws
      6. Drywall T-square
      7. Drywall screwdriver
      8. Rubber mallet
      9. Sawhorses
      10. Caulking gun

   B. Materials

      1. Gypsum wallboard (backer board)
      2. Gypsum wallboard (recessed edge)
      3. Screws
      4. Adhesive

II. Procedure

   A. Install base layer (backer board)

   (NOTE: Stagger panels on opposite side of wall so that joints occur on different studs.)

      1. Position panel with long length placed vertically

      (NOTE: When using vinyl panels for face layer, install base layer horizontally.)

      2. Center edge of panel on stud
      3. Screw panel to stud

JOB SHEET #3

(NOTE: Screw spacing for adhesive laminated face should be 8 inches on center at joints and 12 inches on center in the field.)

4. Continue installing panels, repeating steps A-1 through A-3 until base layer is complete

B. Install face panel

1. Cut panel for length

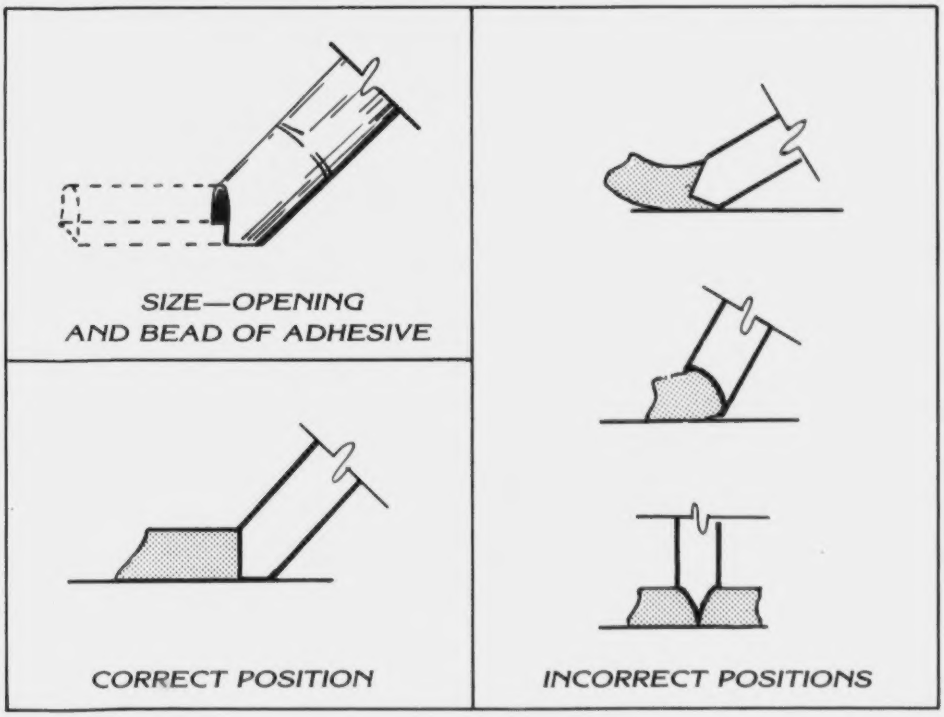
(NOTE: Face panel will be installed horizontally.)

2. Lay panel on sawhorses with back side up

3. Spread adhesive on panel using caulking-gun or spreader method (Figures 31 and 32)

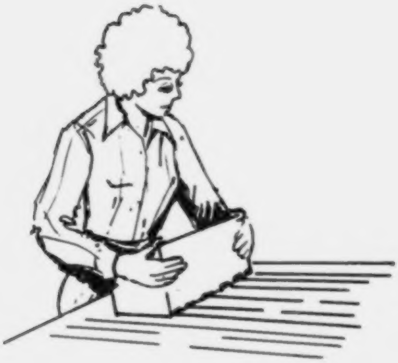
(NOTE: When using a caulking gun, adhesive beads should be 3/8 inch wide by 1/2 inch high and maximum of 2 inches on center.)

FIGURE 31: Caulking-gun method


SIZE—OPENING
AND BEAD OF ADHESIVE
CORRECT POSITION
INCORRECT POSITIONS

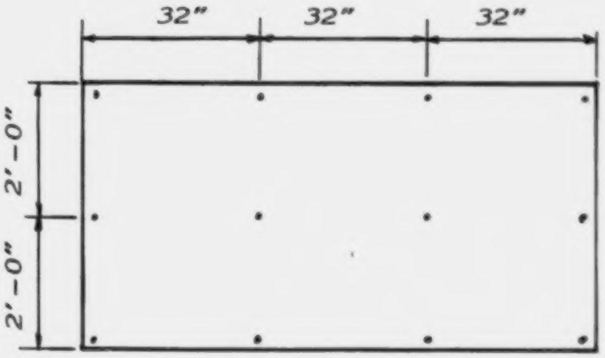
JOB SHEET #3

FIGURE 32: Spreader method



4. Position top panel on base panel horizontally
5. Temporarily nail panel and impact entire area with a rubber mallet to assure good bond
6. Screw panel to studs, using pattern shown in Figure 33 (Figure 33)

FIGURE 33



7. Impact entire area with a rubber mallet to assure bond
8. Nail panel to studs (wood studs)
   a. Nail panels on edge where tape will cover
   b. Drive temporary nails in field of panel

JOB SHEET #3

(NOTE: Duplex nails or scraps of gypsum wallboard and any smooth nail long enough may be used to penetrate the stud.)

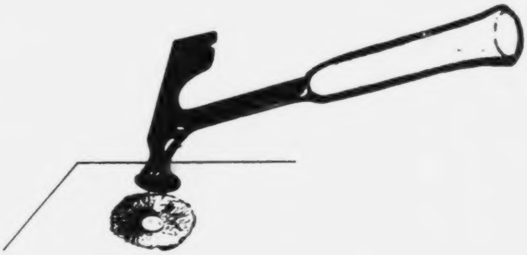
c. Leave temporary nailing for twenty-four hours

9. Place a block of wood under hammer and remove temporary nailing

(NOTE: Do not break face paper.)

10. Dimple nail hole with drywall hammer (Figure 34)

FIGURE 34



C. Clean up area and put away tools and materials

DRYWALL
UNIT II

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with drywall to their correct definitions. Write the correct numbers in the blanks.

_____a. Compound used to embed perforated tape to wallboard joints, to finish over tape and corner bead, and to finish over nail and screw heads

_____b. Paper tape used as reinforcement at wallboard joints to keep surface from cracking

_____c. Pattern used when two nails are spaced 2 inches apart every 12 inches; pattern used on intermediate joists and studs

_____d. Rigid sheathing material made with a noncombustible core (usually gypsum) that is surfaced with treated paper or some other sheet material; sheathing material applied to interior finish walls and ceilings

_____e. Finish coat of compound that covers all previous coats

_____f. Strips of wood nailed on top of top plate between joists and at inside wall angles of partitions; provides a solid base for nailing wallboard

_____g. Joint compound applied to depression formed by butt joints and tapered wallboard edges

_____h. Place where edges of two pieces of wallboard meet

_____i. Any rigid sheathing material applied to interior finish walls and ceilings

_____j. Impression on wallboard surface formed by a nail driven to proper depth

_____k. To make by uniting two or more layers of material

_____l. Compound specially blended to set in from 20 to 90 minutes; is used almost exclusively in constructing manufactured housing

_____m. To spread joint compound or topping so that it tapers to a thin edge

1. Drywall
2. Wallboard
3. Backing
4. Joint
5. Perforated tape
6. Joint compound
7. Bedding
8. Topping
9. Featheredge
10. Quick-weld compound
11. Dimple
12. Double nailing
13. Laminate

TEST

2. Name five types of gypsum wallboard.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

3. Select from the following list standard sizes of gypsum wallboard. Write an "X" in the blank before each correct answer.

______a. 1/2 inch thick

______b. 6 feet wide

______c. 4 feet long

______d. 5/8 inch thick

______e. 1 inch thick

______f. 1/4 inch thick

______g. 16 feet long

______h. 5 feet long

______i. 4 feet wide

______j. 1 1/4 inches thick

______k. 8 feet long

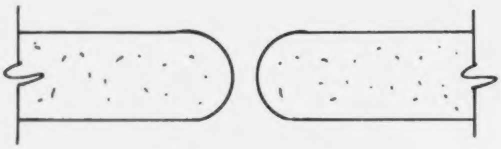
______l. 12 feet long

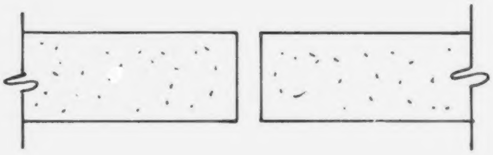
______m. 3/8 inch thick

______n. 10 feet long

4. Identify the standard edge shapes of gypsum wallboard illustrated below and on the following page. Write the correct names in the blanks.

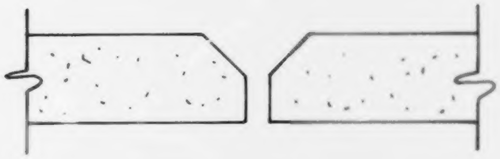
Tongue and groove (T & G) **Beveled** **Tapered** **Round** **Square**



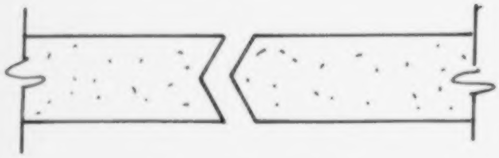


a. ______________________________ b. ______________________________

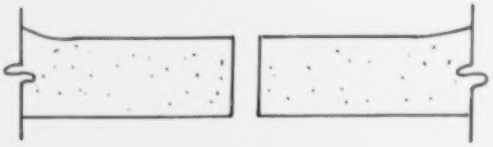
TEST



c. ______________________________



d. ______________________________



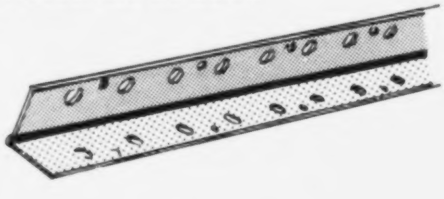
e. ______________________________

5. State four benefits of using gypsum wallboard.
   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________
6. Describe three types of base or construction where wallboard is used.
   a. ______________________________
   ____
   b. ______________________________
   ____
   c. ______________________________
   ____

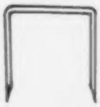
TEST

7. Identify the following illustrations of hardware and fasteners used with gypsum wallboard. Write the correct names in the blanks. Some answers will be used more than once.

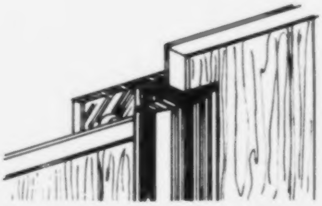
Outside-corner molding for predecorated wallboard	**Metal casing bead**
Phillips-head screw	**Expansion joint**
Coated nail	**Staple**
Annular-ring nail	**Metal corner bead**
Divider molding for predecorated wallboard	**Flex-tape corner**



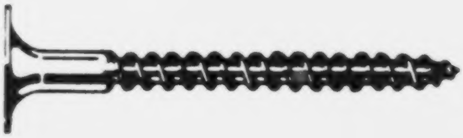
a. ______________________



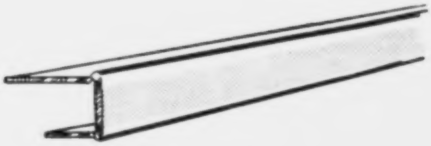
b. ______________________



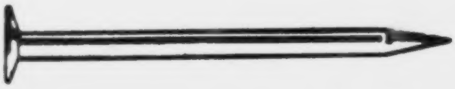
c. ______________________



d. ______________________

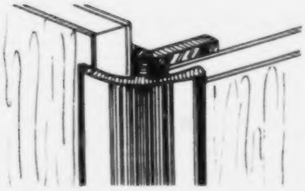


e. ______________________

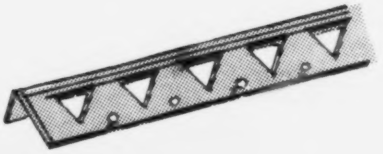


f. ______________________

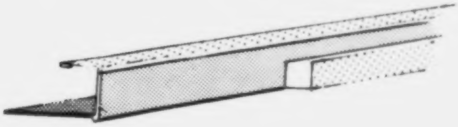
TEST



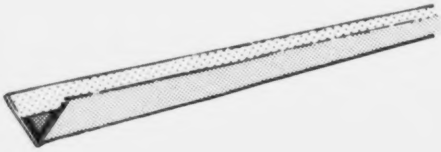
g. ______________________________



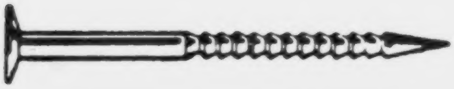
h. ______________________________



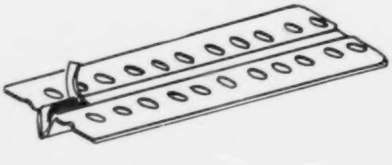
i. ______________________________



j. ______________________________



k. ______________________________



l. ______________________________

8. Select from the following list types of finishes that may be applied to gypsum wallboard. Write an "X" in the blank before each correct answer.

_____a. Acoustical tile
_____b. Paneling
_____c. Quarry tile
_____d. Texture
_____e. Paint
_____f. Plaster
_____g. Predecorated finishes
_____h. Ceramic tile
_____i. Wallpaper
_____j. Plastic laminate

TEST

9. Using the floor plan below and the table on the following page, estimate the materials needed to dry wall the room's walls and ceiling. Write the correct answers in the blanks. Show your work.

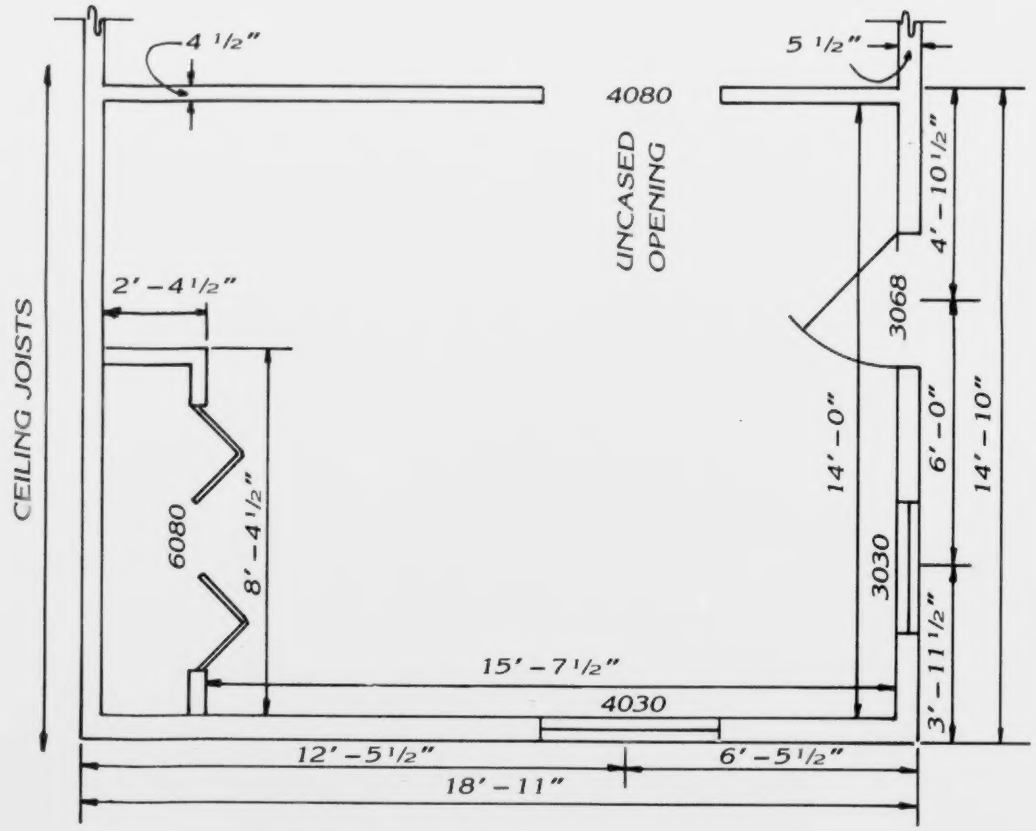
   a. Square feet of 1/2-inch gypsum wallboard needed = ______________________

   b. Pounds of 1 1/4-inch drywall screws needed = ______________________

   c. Feet of perforated tape needed = ______________________

   d. Amount of joint compound needed = ______________________

   e. Number of outside metal corners (8-foot length) needed = ______________________


4 1/2"
5 1/2"
4080
UNCASED OPENING
2'-4 1/2"
CEILING JOISTS
6080
8'-4 1/2"
14'-0"
3068
4'-10 1/2"
6'-0"
14'-10"
3030
3'-11 1/2"
15'-7 1/2"
4030
12'-5 1/2"
6'-5 1/2"
18'-11"

TEST

Fastening and Finishing Materials Required for 1,000 Square Feet of Wallboard

Material	Amount
1¼" annular-ring nail	6¼ lb
1⅜" annular-ring nail	6¾ lb
1" drywall screw	3 lb
1¼" drywall screw	4¼ lb
1⅝" drywall screw	5½ lb
Ready-mix joint compound	80 lb (50-lb container)
Dry joint compound	50 lb (25-lb bag)
Perforated tape	370 lin ft
Texture paint	10 lb to 50 lb (25-lb bags)

(NOTE: Test question 10 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

10. Demonstrate the ability to

    a. Install gypsum wallboard.

    b. Finish wallboard joints and depressions.

    c. Apply laminated gypsum wallboard.

DRYWALL
UNIT II

ANSWERS TO TEST

1. a. 6
   b. 5
   c. 12
   d. 2
   e. 8
   f. 3
   g. 7
   h. 4
   i. 1
   j. 11
   k. 13
   l. 10
   m. 9

2. Answer should include any five of the following

   a. Regular
   b. Type "X"
   c. Insulating
   d. Backing board
   e. Core board
   f. Fire code
   g. Waterproof
   h. Predecorated

3. a, c, d, e, f, g, i, k, l, m, n

4. a. Round
   b. Square
   c. Beveled
   d. Tongue and groove (T & G)
   e. Tapered

5. Answer should include any four of the following

   a. Is easily applied
   b. Is economical
   c. Is easily maintained
   d. Is easily repaired
   e. Is noncombustible
   f. Provides a good base for applying finish materials

6. Answer should include any three of the following

   a. Single layer applied to wood framework
   b. Single layer applied to metal framework
   c. Single layer applied directly to masonry walls
   d. Single layer applied to wood or metal furring strips
   e. Single layer used as subflooring
   f. Double layer (two-ply) nailed, screwed, or laminated to base layer

7. a. Metal corner bead
   b. Staple
   c. Divider molding for predecorated wallboard
   d. Phillips-head screw
   e. Metal casing bead
   f. Coated nail
   g. Outside-corner molding for predecorated wallboard
   h. Metal corner bead
   i. Metal casing bead
   j. Flex-tape corner
   k. Annular-ring nail
   l. Expansion joint

ANSWERS TO TEST

8. a, b, d, e, g, h, i

9. (NOTE: Because estimating answers will vary considerably, answers should be evaluated to the satisfaction of the instructor.)

   a. 812 or 914
   b. $5^{1}/_{4}$ or $5\ ^{3}/_{4}$
   c. 300 or 338
   d. 65 or 73 (2 containers)
   e. 3 or 5

10. Performance skills evaluated to satisfaction of the instructor

INTERIOR WALLS AND CEILINGS
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able to recognize the different types of wall and ceiling finish materials and be able to install various types of materials using various installation methods. Additionally, the student should be able to install associated trim materials. The student will show this knowledge by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match to their correct definitions terms associated with walls, ceilings, and trim.
2. List types of partition walls used in commercial structures.
3. List materials used to finish walls and ceilings.
4. Name styles of paneling.
5. Identify joint treatments for paneling.
6. Estimate the number of 4′ × 8′ sheets needed to panel a room.
7. List materials used to fabricate ceiling tile.
8. List factors that influence type of ceiling tile to be used.
9. Estimate the number of ceiling tiles needed to finish a ceiling.
10. List types of suspended ceiling systems.
11. Identify types of interior trim.
12. Estimate material needed to trim a room.
13. Demonstrate the ability to
    - a. Install V-grooved paneling and trim.
    - b. Install panel wainscot and trim.
    - c. Install furring strips on a masonry wall.
    - d. Install ceiling tile over drywall.

OBJECTIVE SHEET

e. Install furring strips on ceiling joists and ceiling tile on furring.

f. Install suspended ceiling system.

g. Install door trim.

h. Install window trim.

INTERIOR WALLS AND CEILINGS
UNIT III

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Supplement #1 — Methods Used to Install Wall and Ceiling Materials

  D. Information sheet

  E. Assignment Sheet #1 — Estimate Materials Needed to Trim Room

  F. Job sheets

    1. Job Sheet #1 — Install V-Grooved Paneling and Trim

    2. Job Sheet #2 — Install Panel Wainscot and Trim

    3. Job Sheet #3 — Install Furring Strips on a Masonry Wall

    4. Job Sheet #4 — Install Ceiling Tile over Drywall

    5. Job Sheet #5 — Install Furring Strips on Ceiling Joists and Ceiling Tile on Furring

    6. Job Sheet #6 — Install Suspended Ceiling System

    7. Job Sheet #7 — Install Door Trim

    8. Job Sheet #8 — Install Window Trim

  G. Test

  H. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain materials to supplement unit.

    1. Photographs of rooms with a creative use of wall finishes

    2. Samples of materials used to finish walls and ceilings

    3. Plans and schedules showing wall-finishing requirements

SUGGESTED ACTIVITIES

4. Samples of materials used to fabricate ceiling tiles

5. Plans for students to use in estimating the number of ceiling tiles needed to finish a ceiling

6. Transparencies and competency profiles

   (NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W. Washington, D.C. 20006, phone 202-393-2040.)

C. Introduce unit.

SUGGESTIONS:

- Have the class think about the walls, ceilings, and trim in schools, restaurants, offices, etc., that they have visited. Discuss the role of wall finishes in creating a particular atmosphere—such as deeply textured wood paneling to convey a sense of luxury or masculinity or a thick plaster to capture a Spanish atmosphere.
- Display photographs of rooms making creative use of wall finishes, especially thoses combining two or more application techniques. Discuss the use of wall and ceiling finishes to achieve an effect.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

1. Use Information Sheet, Section I to discuss terms and definitions associated with interior wall and ceiling finishes.

   SUGGESTION:

   - Use actual examples of equipment and materials where possible.

2. Use Information Sheet, Section II to discuss materials used to finish walls and ceilings.

   SUGGESTIONS:

   - Take a field trip to various commercial buildings and have students point out the various types of partition walls that they see.

SUGGESTED ACTIVITIES

- Explain to the students that permanent partition walls may be constructed and covered with various types of materials.

  EXAMPLES:

  Wood Frame — Drywalled, Plastered, Paneled, Tiled

  Metal Frame — Drywalled, Plastered, Paneled, Tiled

  Masonry — Poured in place concrete, tilt up concrete, concrete block, brick, structural tile

  Glass — Glass block, structural glass and plastics

- Also explain that partition walls may serve different purposes such as sound control, fire resistance, area separations.

3. Use Information Sheet, Section III to discuss materials used to finish walls and ceilings.

   SUGGESTIONS:

   - Have a representative from a manufacturer or distributor of wall and ceiling finish materials talk to the class about types of materials used.
   - Display samples of the various finish materials discussed in this section of the information sheet.
   - Use Supplement #1 to discuss the methods used to install wall and ceiling finish materials.

4. Use Information Sheet, Sections IV and V to discuss styles of paneling and joint treatments for paneling.

   SUGGESTION:

   - Take the class to visit a paneling manufacturer or distributor to see the various styles of paneling and to obtain information about uses, costs, and availability of the various styles of paneling.

5. Use Information Sheet, Section VI to discuss estimating the number of 4′ × 8′ sheets needed to panel a room.

   SUGGESTIONS:

   - Point out that the steps described in the information sheet are strictly for use with 4′ × 8′ sheets with walls of not much more than 8′ × 0″; review previously learned estimating techniques and relate them to specific wall finish materials.

SUGGESTED ACTIVITIES

- Provide students with plans and schedules and have them estimate wall finish material requirements.
- Demonstrate the procedures in Job Sheets #1 through #3.

  (NOTE: These procedures are written to provide practice with a number of materials and application techniques. You may want to emphasize materials and practices common in your area.)
- Have students complete Job Sheets #1 through #3.

6. Use Information Sheet, Sections VII and VIII to discuss materials used to fabricate ceiling tiles and factors that influence the type of ceiling tile to be used.

   SUGGESTIONS:

   - Display samples of the various types of fabrication materials, and discuss the applications of each. Relate the various materials to the factors that influence the selection of a tile.
   - Have a representative from a manufacturer or distributor of ceiling tile discuss the product with the class.

7. Use Information Sheets, Sections IX and X to discuss estimating the number of ceiling tiles needed to finish a ceiling and types of suspended ceiling systems.

   SUGGESTIONS:

   - Provide students with plans and have them estimate materials and costs for a plan using various sizes and styles of ceiling tile.
   - Demonstrate the procedures in Job Sheets #4, #5, and #6.
   - Have students complete Job Sheets #4, #5, and #6.

8. Use Information Sheet, Section XI and XII to discuss types of trim and estimating trim.

   SUGGESTIONS:

   - Provide the class with samples of various types of trim in a number of sizes, styles, and materials.
   - Discuss applications and installation of trim.

SUGGESTED ACTIVITIES

- Discuss different types of joints used on trim.

  EXAMPLES: Butt, mitered, coped

- Demonstrate how to cut each of the joints.
- Visit job sites to view trim application.
- Make flashcards of the various types and styles of trim. Use the cards to help class learn to identify the different types and styles.
- Have a materials supplier discuss ordering procedures and the availability to trim materials used in your area.
- Use Assignment Sheet #1 to allow students to practice estimating trim material.
- Provide students with floor plans and schedules, and have them write order for trim.
- Demonstrate the procedures in Job Sheets #7 and #8.

H. Review unit.

I. Give test.

J. Critique test and discuss in class.

K. Reteach if necessary.

L. Complete appropriate sections of competency profiles.

III. Unit references

A. Hendrix, Laborn J. "Bud." *Commercial Carpentry.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1979.

B. Hendrix, Laborn J. "Bud." *Residential Carpentry.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Industrial Materials Center, and The Associated General Contractors of America, 1985.

C. "Molding Chart," Dallas, Texas: Southwest Molding Company.

D. Wagner, Willis H. *Modern Carpentry.* South Holland, Illinois: The Goodheart-Wilcox Company, 1976.

SUGGESTED ACTIVITIES

SUPPLEMENT #1 — METHODS USED TO INSTALL WALL AND CEILING MATERIALS

Material*	Location	Method
Plaster	Wall or ceiling	Applied by hand or machine over lath or backing
Drywall	Wall	Attached to studs by nails, screws, staples, or adhesive
		Attached to furring strips over masonry walls
	Ceiling	Attached to joists with nails or screws
		(NOTE: An exposed-beam appearance can be created with drywall by installing solid, built-up, or false beams over the drywall.)
Tile		
Ceramic	Wall or ceiling	Applied with adhesive or in a base material such as grout
Acoustical	Wall	Applied directly to drywall with nails, staples, or adhesive
	Ceiling	Usually attached to furring strips
		Laid in a metal framework for suspended ceilings
Solid lumber	Wall or ceiling	Nailed with exposed nails or blind nailing directly to framing members, drywall, or furring strips
Selected tongue-and-groove lumber	Ceiling	Applied directly to roof beams
		(NOTE: This is called *exposed beam and deck construction* and requires careful use of vapor barriers and, generally, rigid insulation between the deck and roofing.)
Paneling	Wall	Fastened to studs, drywall, or furring strips with nails or adhesive
		(NOTE: Nails may match color of paneling and installation may or may not include molding.)
Plastic laminate	Wall	Bonded to drywall with adhesive or manufactured with fiberboard or particle-board base

*The materials listed are those that generally require installation or special preparation by the carpenter.

INTERIOR WALLS AND CEILINGS
UNIT III

INFORMATION SHEET

I. Terms and definitions

A. Plaster — Mixture of lime, cement, and sand applied to walls and ceilings to finish their surfaces

B. Drywall — Hardboard (usually with gypsum core) used to cover walls and ceilings

C. Plastic laminate — Thin sheet of hard, smooth, synthetic material that is highly resistant to scratching and wear; used for wainscoting and wall paneling

D. Wainscot — Material that covers lower part of an interior wall surface and contrasts with wall surface above

E. Furring — Strips of wood or metal applied to surface to make it straight and plumb and to provide fastening surface for finish covering

F. Adhesive — Glue, cement, mastic, paste, or any substance capable of holding materials together by surface attachment

G. Scribe — Tool with a sharp point used to make irregular marks for cutting and fitting a piece of material

H. Putty stick — Material used to fill holes in finished surface; is color-coded to match finished surface

I. Cap molding — Trim nailed to wall at top edge of wainscoting

J. Cope — To cut or shape the end of a piece of molding so that it will fit the contour of an adjoining piece of molding

K. Lath — Metal, wood, or gypsum panel nailed to stud as backing or base for plaster

L Casing — Framework of trim of various widths and thicknesses used around windows, doors, and other openings.

M. Doorstop — Molding strip on door frame that keeps the door from swinging through.

N. Base — Finish molding covering bottom edge of wall material where the wall and floor meet

O. Astragal — Molding trim attached to inside edge of one of a pair of doors or windows to prevent swinging through; also used with sliding doors to ensure tighter fit where doors meet

P. Batten — Narrow strips of wood or metal trim used to cover joints of sheathing, paneling, or other materials to seal the joints

INFORMATION SHEET

II. Types of partition walls used in commercial structures

   A. Permanent

      EXAMPLES: Wood, metal, masonry, glass, foam core

   B. Movable (Relocatable)

   C. Operable

      EXAMPLES: Folding, sliding, telescoping

      (NOTE: These may be manually or power operated.)

III. Materials used to finish walls and ceilings

   A. Walls

      1. Plaster
      2. Drywall
      3. Ceramic tile
      4. Solid-lumber paneling
      5. Plywood paneling
      6. Plastic laminate
      7. Hardboard paneling

   B. Ceilings

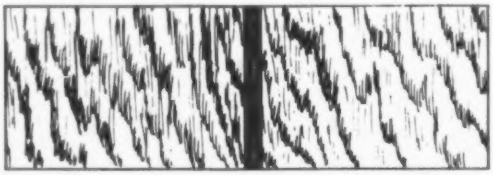
      1. Plaster
      2. Drywall
      3. Drywall with exposed beams
      4. Ceiling tile
      5. Exposed roof-deck and beams

IV. Styles of paneling (Figures 1-3)

   A. V-grooved

      EXAMPLE:

   FIGURE 1

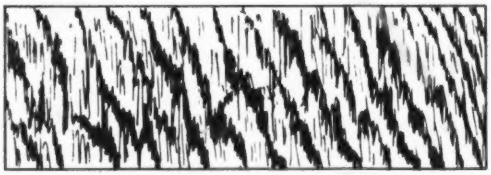


INFORMATION SHEET

B. Plain

EXAMPLE:

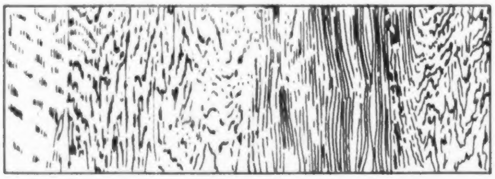
FIGURE 2



C. Brushed

EXAMPLE:

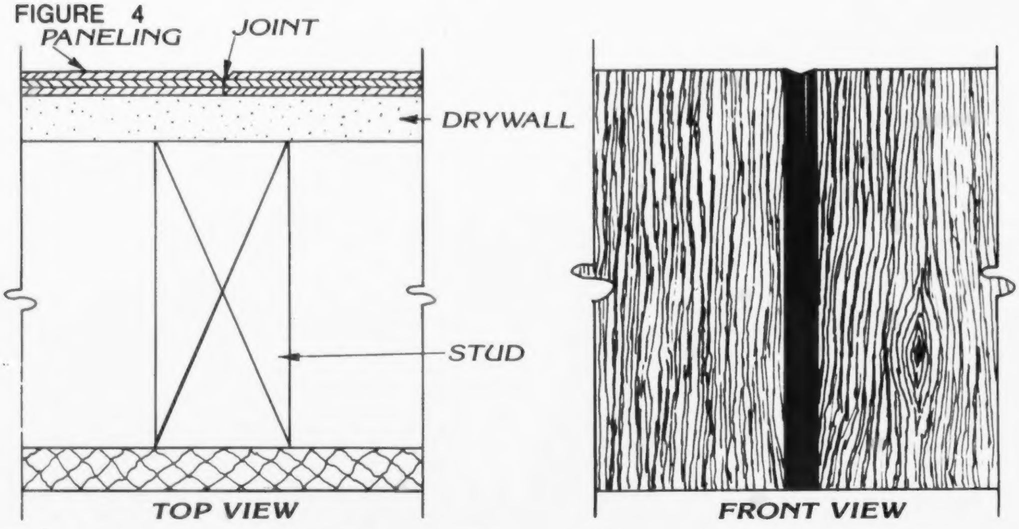
FIGURE 3



IV. Joint treatments for paneling (Figures 4-6)

A. Butt joint with V-groove

FIGURE 4

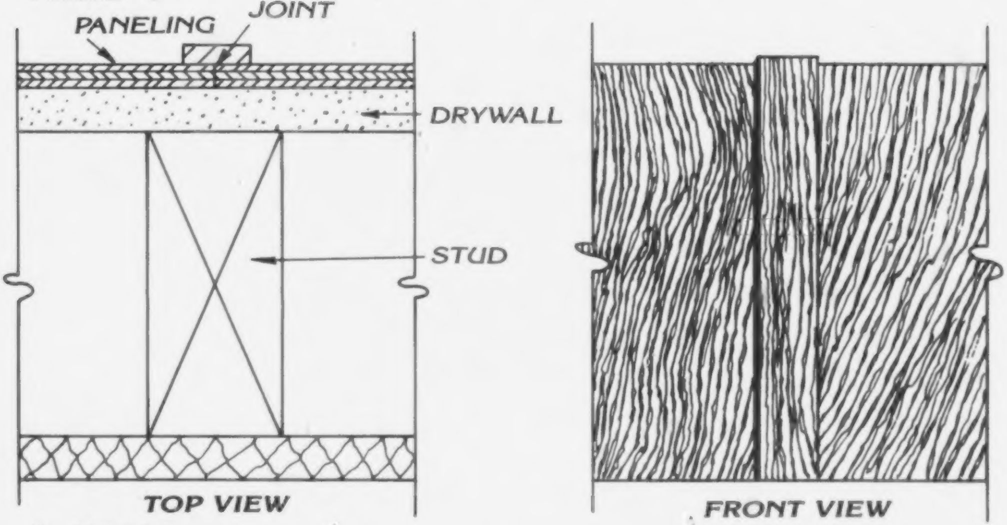


PANELING
JOINT
DRYWALL
STUD
TOP VIEW
FRONT VIEW

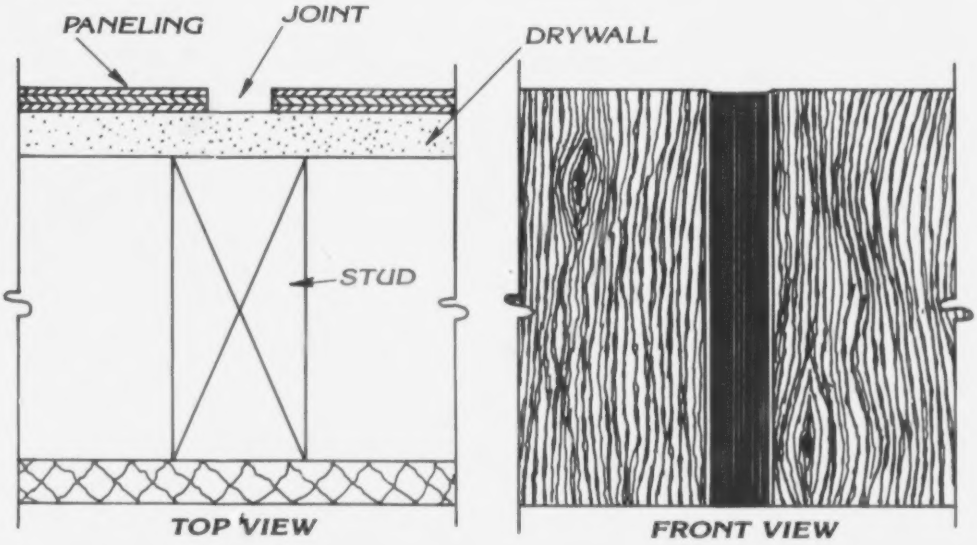
INFORMATION SHEET

B. Batten strip

FIGURE 5


PANELING
JOINT
DRYWALL
STUD
TOP VIEW
FRONT VIEW

C. Open joint


PANELING
JOINT
DRYWALL
STUD
TOP VIEW
FRONT VIEW

VI. Estimating the number of 4′ × 8′ sheets needed to panel a room

(NOTE: The procedure described below is a guideline for determining the number of 4′ × 8′ sheets needed to panel interior walls that are 8 feet high or less. For panels in other sizes, follow the procedures in steps A through C and then divide by the coverage provided by each unit of material. Also, when estimating perimeters, figure to the next largest full foot, if necessary.)

A. Check plans or measure to determine perimeter length of each wall

INFORMATION SHEET

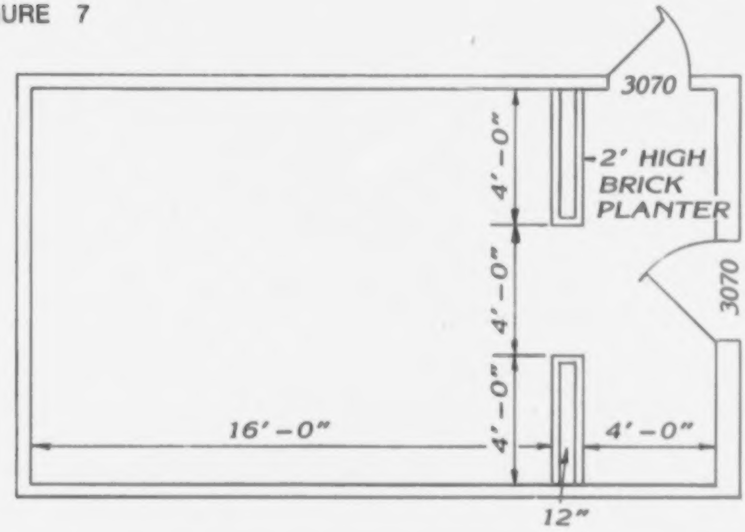
B. Check plans or measure to determine perimeter length of partitions and offset walls, if any

C. Add perimeters of all walls to find total perimeter

EXAMPLE: If the perimeters of the walls of a room are 21 feet, 12 feet, 21 feet, and 12 feet (See Figure 7), then

21' –0"
12' –0"
21' –0"
12' –0"
66' –0" = total perimeter

FIGURE 7



D. Divide total perimeter by 4 to find the number of 4' × 8' sheets needed; round up to next whole number if necessary

EXAMPLE: If the total perimeter of a room is 66 feet, then

66' ÷ 4' = 16½ or 17 sheets needed to panel room

VII. Materials used to fabricate ceiling tile

(NOTE: Ceiling tiles are manufactured in various sizes, surface patterns, and textures.)

A. Fiberboard

B. Mineral

C. Perforated metal

INFORMATION SHEET

D. Glass fiber

E. Mirror

VIII. Factors that influence type of ceiling tile to be used

A. Appearance

B. Initial cost

C. Ease of installation

D. Light reflection

E. Fire resistance

F. Sound absorption

G. Maintenance cost

H. Insulation value

IX. Estimating the number of ceiling tiles needed to finish a ceiling

A. Check plans or measure to find length and width of room

B. Round dimensions up to next whole foot, if necessary

EXAMPLE: If the room's actual measurements are 13′ − 8″ × 29′ − 4″, then use 14′ × 30′ when you are estimating.

C. Multiply length times width to find square footage of ceiling to be tiled

EXAMPLE: If a room's measurements are 14 feet × 30 feet, then

14′ × 30′ = 420 sq ft of ceiling to be tiled

D. Check packaging or measure to determine number of square feet covered by each tile

E. Divide square footage of ceiling to be tiled by square feet covered per tile to find number of tiles needed

EXAMPLE #1: If there are 420 square feet of ceiling and each 12″ × 12″ tile will cover 1 square foot, then

420 ÷ 1 = 420 tiles needed to finish ceiling

EXAMPLE #2: If there are 420 square feet of ceiling and each 12″ × 24″ tile will cover 2 square feet, then

420 ÷ 2 = 210 tiles needed to finish ceiling

EXAMPLE #3: If there are 420 square feet of ceiling and each 24″ × 48″ tile will cover 8 square feet, then 420 ÷ 8 = 52 ½ or 53 tiles needed to finish ceiling

INFORMATION SHEET

X. Types of suspended ceiling systems

   A. Exposed grid systems

   B. Semi-concealed joint systems

   C. Concealed grid systems

      1. Zee bar

      2. Tee

      3. Double-leaf access

   D. Integrated system

   E. Suspended drywall furring system

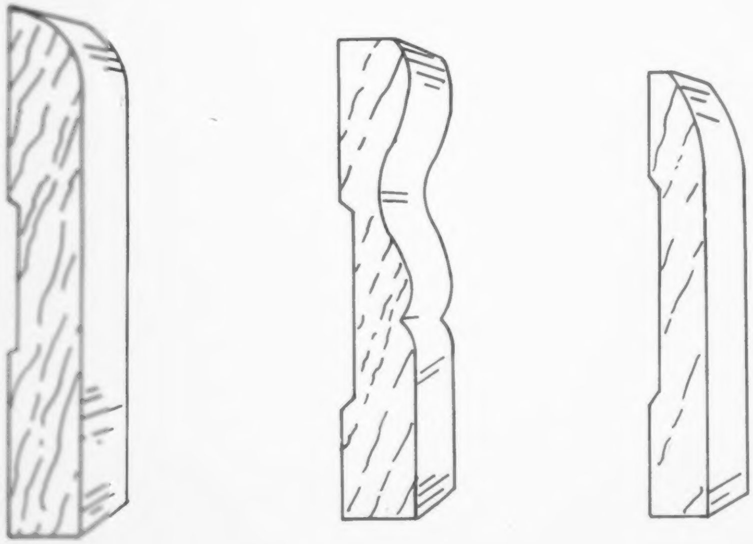
   (NOTE: Some of these systems combine other functions such as sound control, comfort, lighting, aesthetic values)

XI. Types of interior trim (Figures 8-21)

   (NOTE: Examples of molding styles include colonial, sanitary, step, k, and h.)

   A. Base

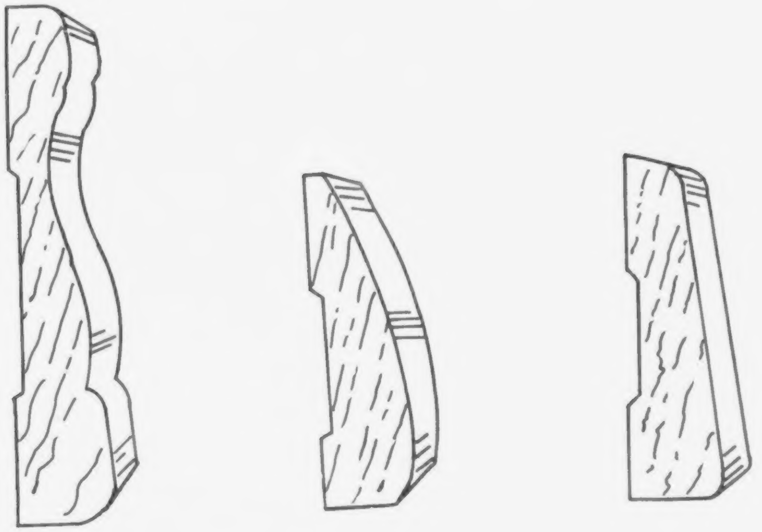
FIGURE 8



INFORMATION SHEET

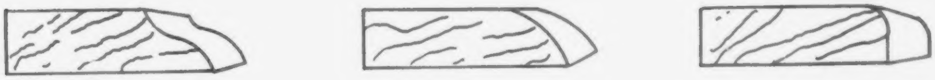
B. Casing

FIGURE 9



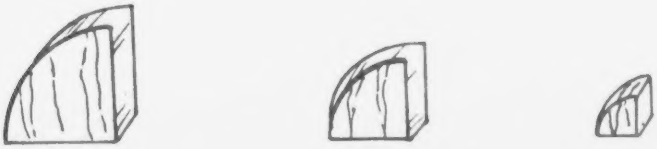
C. Doorstop

FIGURE 10



D. Quarter round

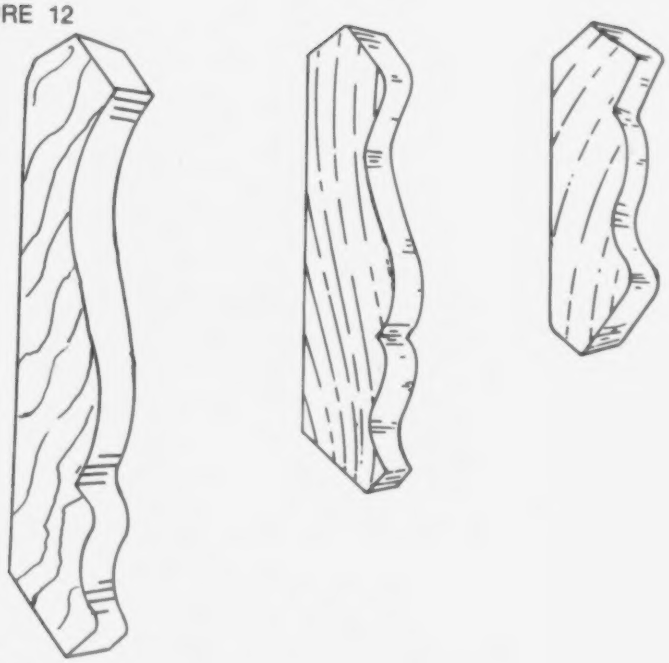
FIGURE 11



INFORMATION SHEET

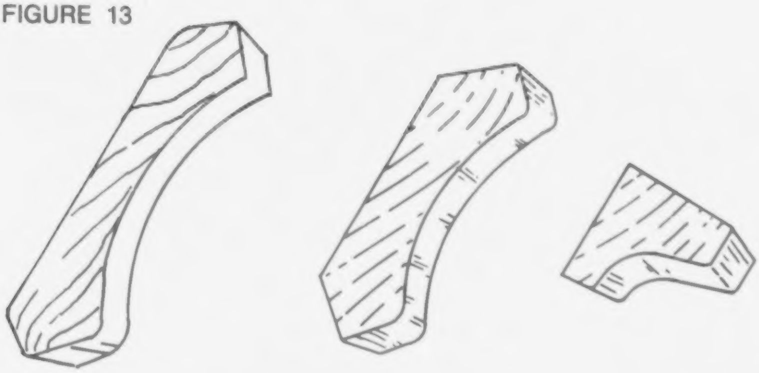
E. Crown

FIGURE 12



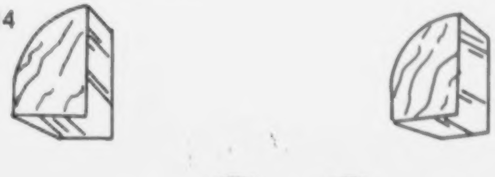
F. Cove

FIGURE 13



G. Shoe molding (base shoe)

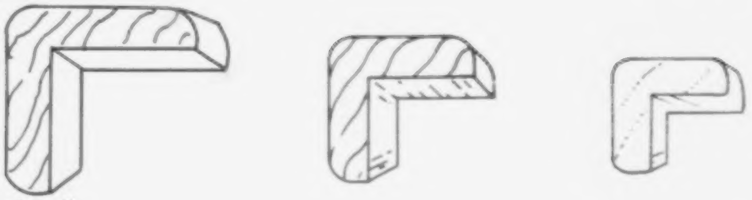
FIGURE 14



INFORMATION SHEET

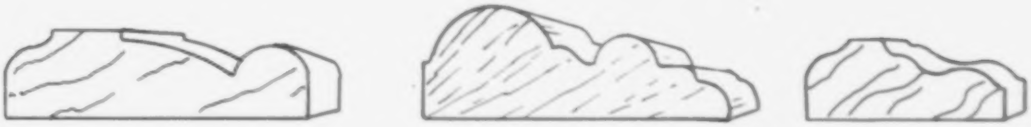
H. Outside corner

FIGURE 15



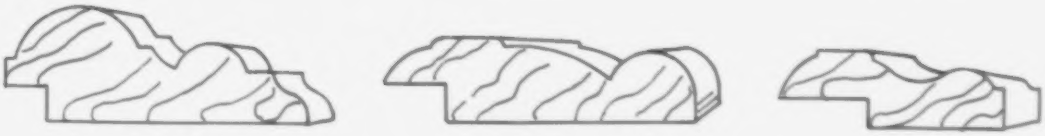
I. Chair rail

FIGURE 16



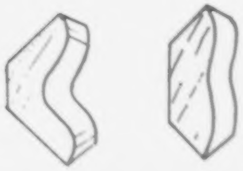
J. Cap molding (cap strip)

FIGURE 17



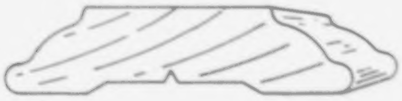
K. Inside corner

FIGURE 18



L. Batten

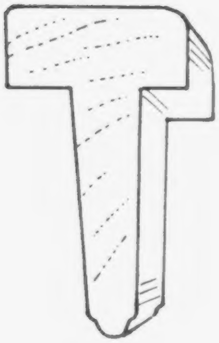
FIGURE 19



INFORMATION SHEET

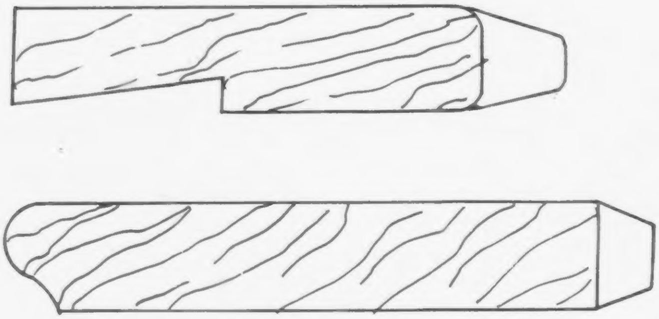
M. T-astragal

FIGURE 20



N. Window stool

FIGURE 21



XII. Trim estimating (Figure 22)

A. Door units (Door stops and casing) — Determine numbers, sizes, styles, and specifications from plans and schedules

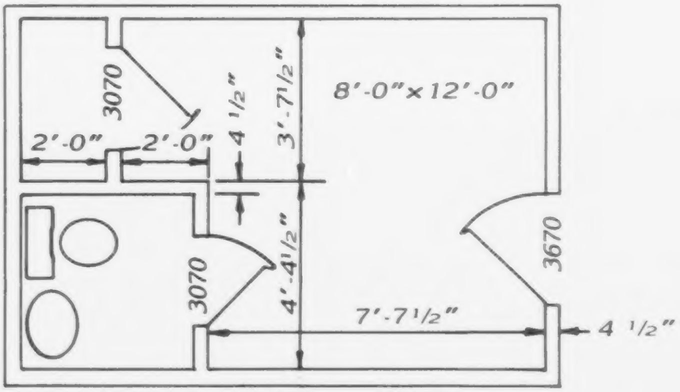
(NOTE: When ordering doors, jamb sets, casing material, door stops, and other specialty trim, specify how many of each are required and other requirements such as those listed in the example below.)

B. Trim — Determine number of lineal feet required from plans, and order each type of trim to the next highest even lineal foot

(NOTE: Schedules and specifications generally list doors, windows, and trim requirements. The listing in the example below is not intended to represent details or specifications but is meant only to show an example of material that might be used for the plan shown.)

EXAMPLE:

FIGURE 22



INFORMATION SHEET

1. Jambs
    a. Two 3/0 × 7/0 interior jamb
    b. One 3/6 × 7/0 interior jamb
2. Casing and doorstops
    a. Four sets 3/0 × 7/0 colonial casing
    b. Two sets 3/6 × 7/0 colonial casing
    c. Two set 3/0 × 7/16 × 1 3/8 O.G. doorstop
    d. One set 3/6 × 7/16 × 1 3/8 O.G. doorstop
3. Trim
    a. 56 lineal feet 1/2 inch × 3 inch colonial base
    b. 56 lineal feet 1/2 inch × 3/4 inch shoe molding
    c. 8 lineal feet 1 inch × 1 inch outside corner

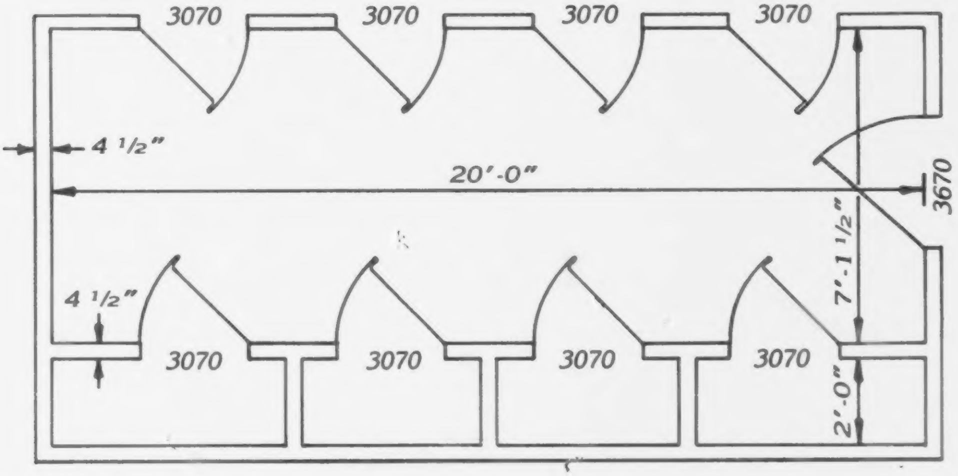
INTERIOR WALLS, CEILING, AND TRIM
UNIT III

ASSIGNMENT SHEET #1 — ESTIMATE MATERIALS NEEDED TO TRIM A ROOM

NAME ______________________________ SCORE ____________

The competent carpenter knows how to estimate materials quickly and accurately for a specific job. Accurate estimation is cost effective and eliminates needless waste of materials and time. This exercise is meant to help you become a competent estimator.

Estimate the amount of material needed to trim the room illustrated. Write your answers on the next page.



Use 7/16" × 3" san base, 5/8" × 2 1/4" san casing, 7/16" × 3/4" shoe molding. Use two 4" butt hinges on interior door and three on exterior doors. Use streamline Bellflower locksets on each flush-type door. One lockset is privacy; others are passage. San doorstops are 3/8" × 1 3/8". Use WP84, 9/16" × 2 1/4" cove molding in large room only.

ASSIGNMENT SHEET #1

A. Casing

1. Type and size ______________________________

2. Number of set ______________________________

B. Door stop

1. Type and size ______________________________

2. Number of set ______________________________

C. Base

1. Type and size ______________________________

2. Lineal feet ______________________________

D. Shoe mold

1. Size ______________________________

2. Lineal feet ______________________________

E. Cove mold

1. Type and size ______________________________

2. Lineal feet ______________________________

INTERIOR WALLS AND CEILINGS
UNIT III

ANSWERS TO ASSIGNMENT SHEETS

A. Casing

1. Type and size — San casing 5/8" × 2 1/4" for each door size
2. Number of sets — Eight sets 3/0" × 7/0", one set 3/8" × 7/0"

B. Door stops

1. Type and size — San door stops 3/8" × 1 3/8" for each door size
2. Number of sets — Eight sets 3/0" × 7/0", one set 3/6" × 7/0"

C. Base

1. Type and size — San base 7/16" × 3"
2. Lineal feet — 52'

D. Shoe mold

1. Size — 7/16" × 3/4"
2. Lineal feet — 52'

E. Cove mold

1. Type and size — WP 84 9/16" × 2 1/4"
2. Lineal feet — 56

INTERIOR WALLS AND CEILINGS
UNIT III

JOB SHEET #1 — INSTALL V-GROOVED PANELING AND TRIM

I. Tools and equipment

- A. Folding rule or steel tape
- B. 4-foot or 6-foot level
- C. Hammer
- D. Scribe
- E. Framing square
- F. Nail sets
- G. Block plane
- H. Power handsaw and extension cord
- I. Power jigsaw
- J. V-grooved paneling
- K. Inside corners
- L. Outside corners
- M. Base
- N. Putty stick
- O. 3d and 4d finish nails
- P. One pair of sawhorses
- Q. Adhesive and manufacturer's instructions

II. Procedure for installing paneling

(NOTE: Before starting application, be sure paneling has been stored in room at least twenty-four hours prior to installation.)

- A. Stand paneling on end around room and arrange so that adjoining panels match as to grain patterns, color, and groove spacing

JOB SHEET #1

B. Fit first panel

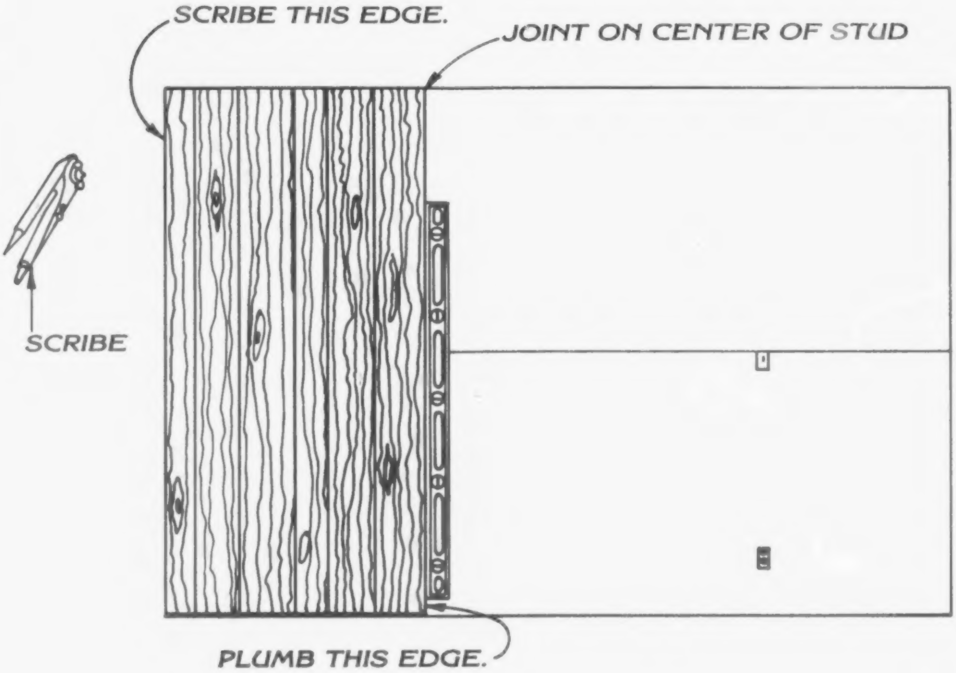
1. Align one edge of panel at inside corner and leading edge over a stud

   (NOTE: The edge opposite the starting point is called the *leading edge*. All joints must fall on studs. See Figure 23.)

2. Plumb leading edge of panel (See Figure 23)

3. Scribe inside-corner edge (Figure 23)

FIGURE 23


SCRIBE THIS EDGE.
JOINT ON CENTER OF STUD
SCRIBE
PLUMB THIS EDGE.

4. Place panel on sawhorses and trim to scribed mark

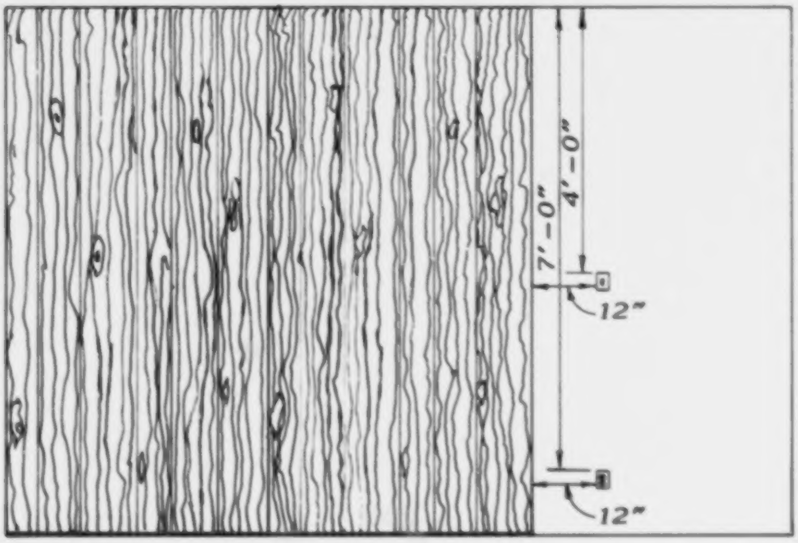
C. Fit remaining panels

1. Align panels with sides of door and window openings whenever possible to conserve material

JOB SHEET #1

2. Measure and lay out cutouts for switches and receptacles
   - a. Measure for cutouts from top of each panel and from leading edge of previous panel (Figure 24)

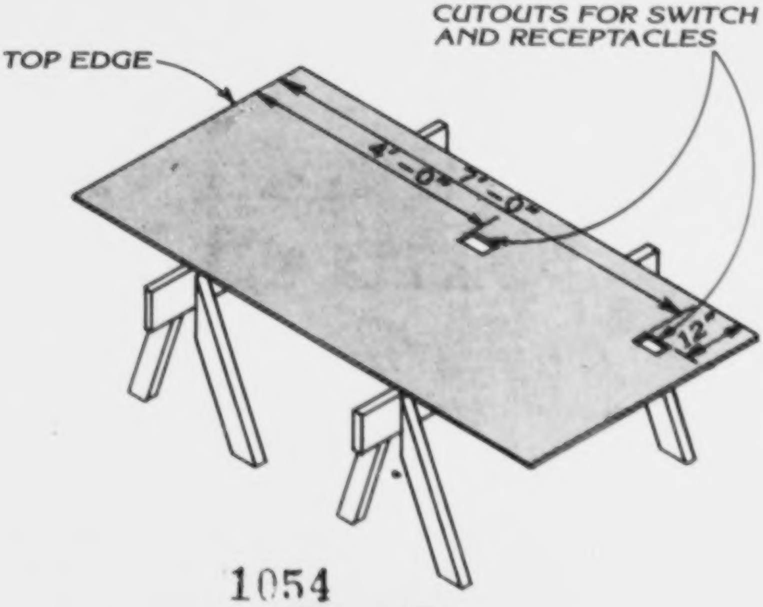
FIGURE 24



   - b. Mark and cut holes on back side of panel (Figure 25)

     (NOTE: Use masking tape at cuts to keep paneling from splintering.)

FIGURE 25


CUTOUTS FOR SWITCH AND RECEPTACLES
TOP EDGE
4'–0"
7'–0"
12"

JOB SHEET #1

   c. Scribe and cut panels to fit corners

D. Color joints if desired

(NOTE: Some carpenters like to color the backing material at each joint with marker, shoe polish, or paint to prevent any of the backing material from showing at joints.)

E. Install panels, using nailing method or adhesive method

1. Nailing method

   a. Beginning at top and working down, nail paneling with 16-inch spacing along each stud

   b. Drive nails nearly flush and then set nails

   c. Fill nail holes using putty stick if required

   (NOTE: Be sure paneling is sealed before using putty stick.)

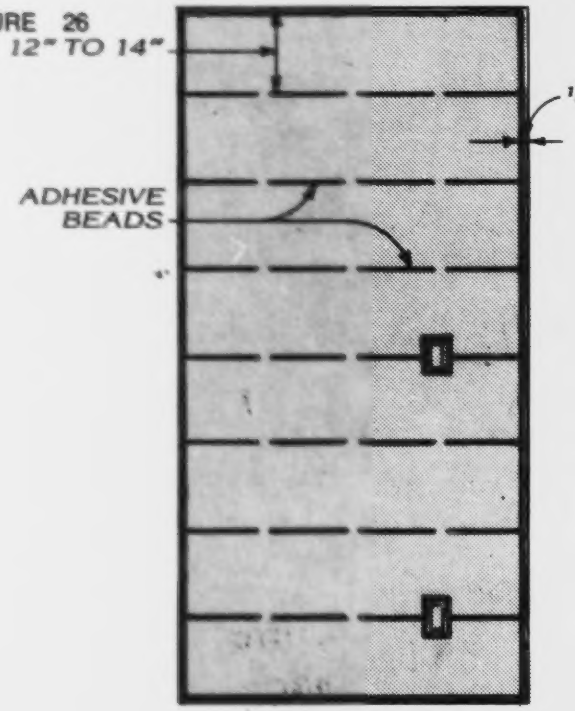
2. Adhesive method

   (NOTE: Follow manufacturer's instructions when instructions differ from following procedure.)

   a. Apply a continuous bead about ½ inch from edge (See Figure 26)

   b. Beginning at top of panel, apply a row of four 6- to 8-inch long beads about every 12 to 14 inches down panel (Figure 26)

FIGURE 26



JOB SHEET #1

c. Press panel to wall

d. After recommended drying time, pull panel from wall at bottom edge and then press panel firmly back into position

(NOTE: This procedure will assure adherence.)

e. Sparingly nail panel if necessary

III. Procedure for installing trim

(NOTE: Paneling is normally trimmed *after* the doors and windows have been trimmed. For those procedures, see Unit IV, "Interior Doors and Trim." Also, paneling is sometimes used for window returns with outside-corner molding at the joints.)

A. Install floor and ceiling trim

1. Fit and install first piece of molding

   a. Beginning in an inside corner, measure to determine length of molding

   b. Cut ends square with miter saw or sawbuck

   (NOTE: Use single pieces of molding as much as possible. Square cut each end if no splice is required. If a splice is required, miter the two pieces of molding to fit with the splice over a stud.)

   c. Nail molding by placing a nail at each stud and then setting each nail

   (NOTE: The size of the nail will depend on the type of molding being used.)

2. Fit and install remaining molding

   a. Cope end of molding piece that will fit against first piece

   (NOTE: The type of joint used may vary depending on the type of finish to be used, job requirements, or installer preference.)

   b. Cut, fit, and nail remaining molding in place until installation is complete

B. Install vertical trim

1. Measure to determine required length

JOB SHEET #1

2. Cut each molding piece to length and miter or cope as required for desired fit

3. Nail in place with a nail near each end of each molding piece and at 12-inch intervals along each strip on alternating sides; set nails

C. Clean work area and put away tools and equipment

INTERIOR WALLS AND CEILINGS
UNIT III

JOB SHEET #2 — INSTALL PANEL WAINSCOT AND TRIM

I. Tools and equipment

- A. Folding rule or steel tape
- B. 30-inch or 3-foot level
- C. Chalk line
- D. Hammer
- E. Scribe
- F. Framing square
- G. Nail sets
- H. Paneling precut to 4′ × $31^{15}/_{16}$″
- I. Cap molding
- J. Base
- K. 3d, 4d, and 6d finish nails
- L. One pair of sawhorses
- M. Power miter saw or sawbuck and extension cord
- N. Power jigsaw

II. Procedure for installing wainscot

(NOTE: Before starting application, be sure paneling has been stored in rooms at least twenty-four hours prior to installation.)

- A. Stand paneling on end around room and arrange so that adjoining panels match as to grain patterns, color, and groove spacing
- B. Establish line for top edge of panels
  1. Measure up from floor $32^{1}/_{4}$ inches and mark wall at each corner and at edge of each opening (See Figure 12)
  2. Snap a chalk line between each of these marks (See Figure 12)

     (NOTE: It may be necessary to use a dry line to avoid staining finish material.)

JOB SHEET #2

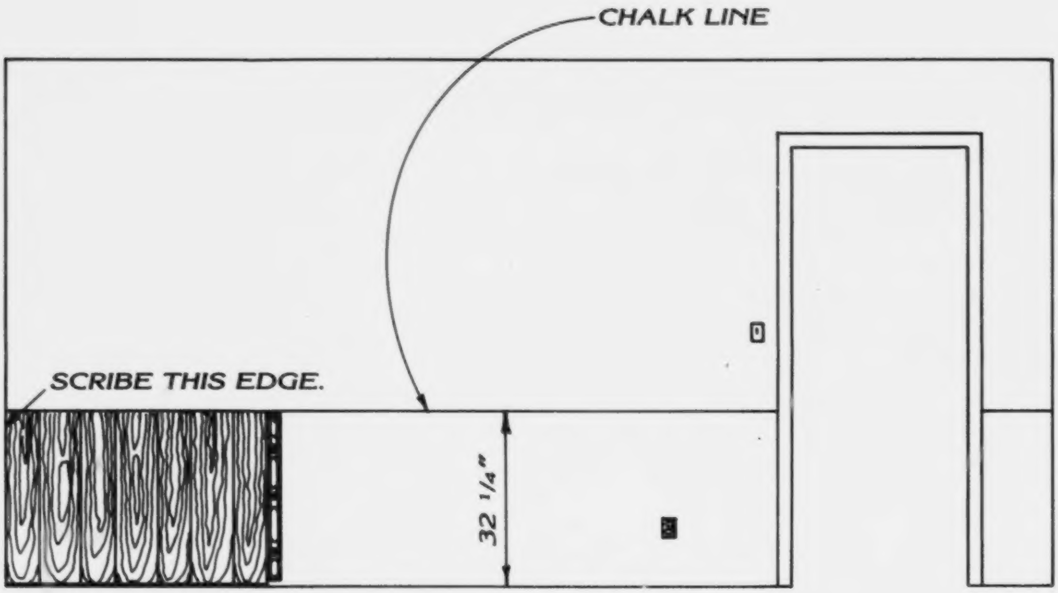
C. Fit first panel at an inside corner

1. Position panel with top along chalk line, one edge at inside corner, and leading edge centered over a stud

   (NOTE: All joints must center over studs.)

2. Plumb leading edge of panel (See Figure 27)
3. Scribe edge of panel to fit inside corner (Figure 27)

FIGURE 27



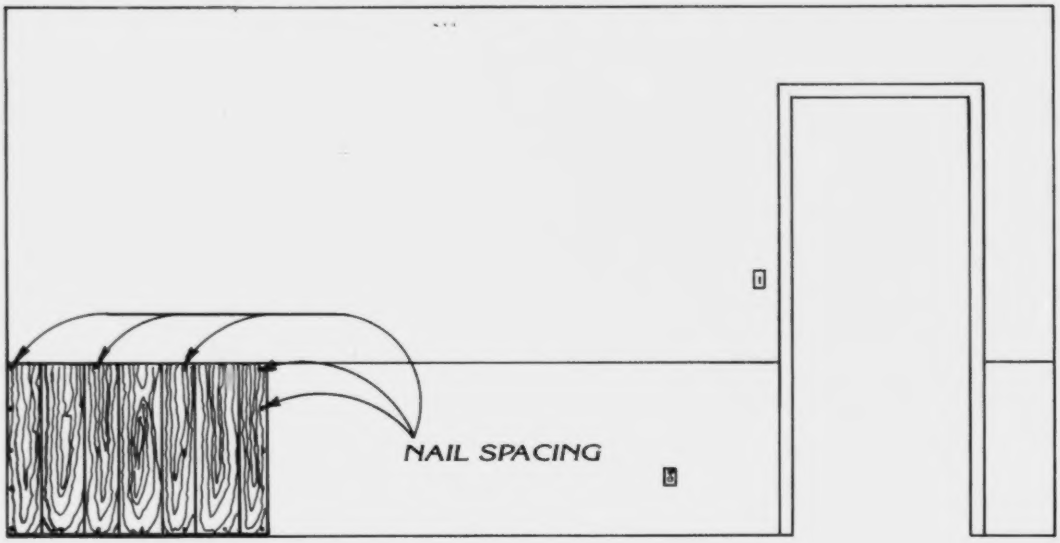
4. Place panel on sawhorses and trim to scribed mark

D. Install first panel

1. Set panel in position and check corner edge for accuracy and leading edge for plumb; make corrections as necessary
2. Nail edges of panel to studs, spacing 3d finish nails about 8 inches apart; nail at top, bottom, and center of panel on intermediate studs, concealing nails under trim whenever possible (See Figure 28)

JOB SHEET #2

FIGURE 28



E. Fit remaining panels

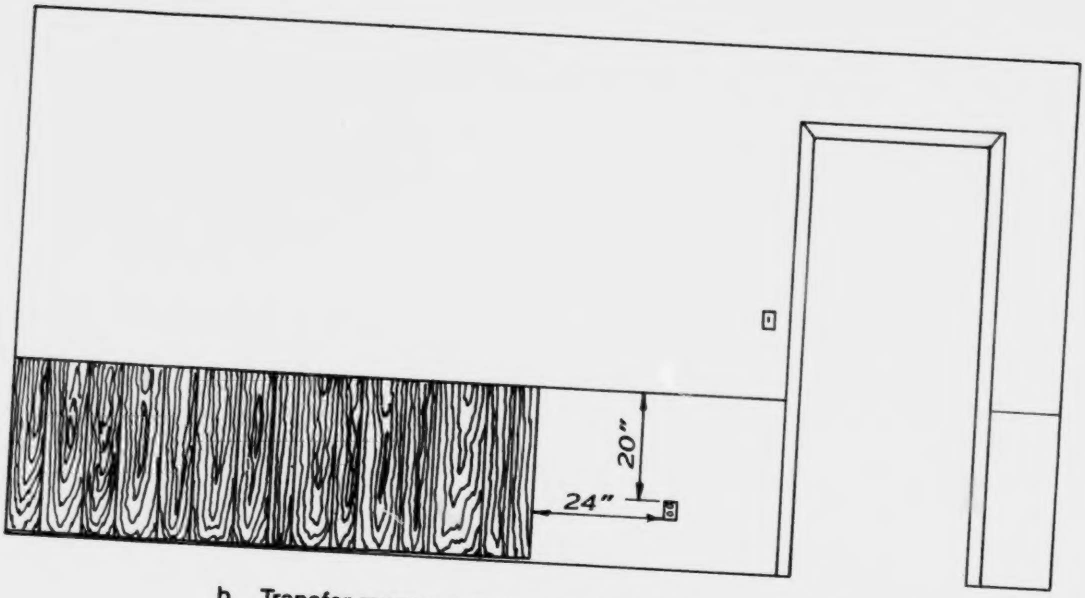
1. Align panels with sides of door and window openings whenever possible to conserve materials

2. Measure and lay out cutouts for switches and receptacles

    a. Measure for cutouts from mark on wall and from leading edge of panel already installed (See Figure 29)

JOB SHEET #2

FIGURE 29

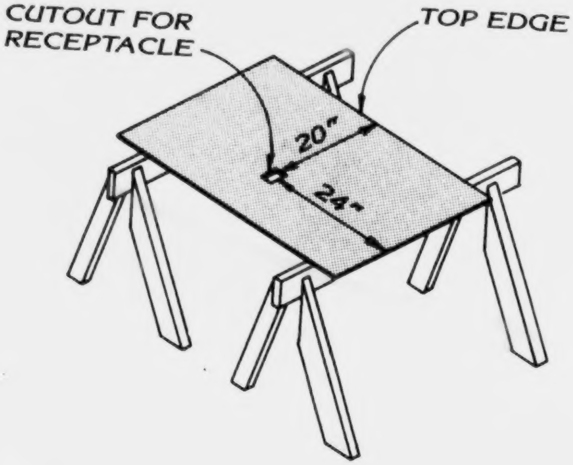


b. Transfer measurement to back side of panel (See Figure 30)

c. Use jig saw to cut out holes on back side of panel (Figure 30)

(NOTE: Use masking tape at cuts to prevent paneling from splintering.)

FIGURE 30


CUTOUT FOR RECEPTACLE
TOP EDGE
20"
24"

F. Install remaining panels following steps D-1 and D-2 for first panel

JOB SHEET #2

III. Procedure for installing trim

(NOTE: Similar procedures are used to install cap molding and baseboard.)

A. Fit and install first piece of molding

1. Beginning in a corner, measure to determine length of first piece of molding
2. Cut ends square with miter saw or sawbuck

   (NOTE: Use single pieces of molding as much as possible. Square-cut each end if no splice is required. If a splice is required, miter the two pieces of molding to fit with the splice over a stud.)

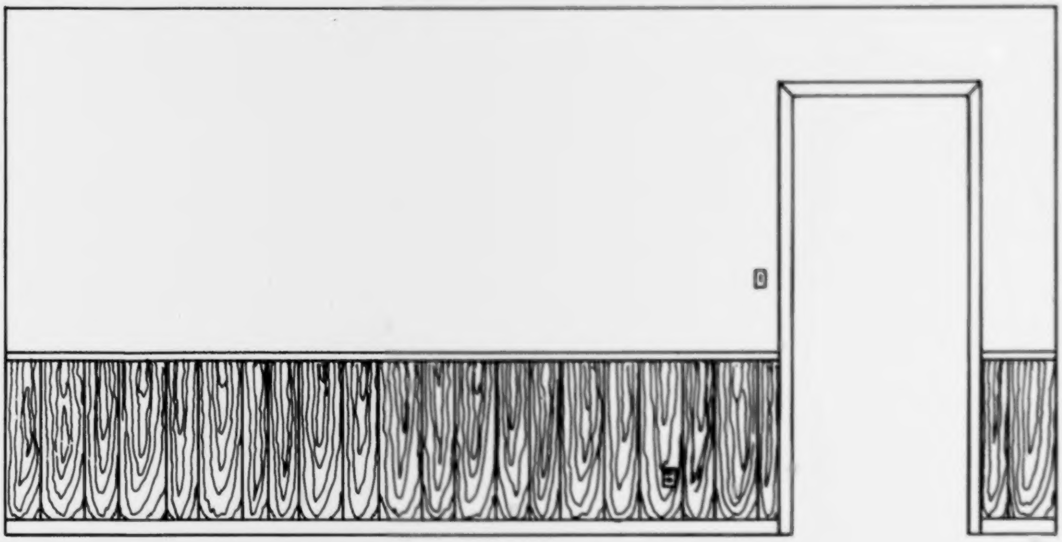
3. Nail molding in place, using 6d finish nails at each stud; set nails

B. Fit and install remaining molding

1. Cope end of molding piece that will fit against first piece
2. Cut, fit, and nail remaining molding in place until installation is complete (Figure 31)

   (NOTE: Type of joints used [miter, coped, or square] depends on the type of finish required, job requirements, or installer preference.)

FIGURE 31



3. Set all nails in trim

C. Clean up area and put away tools and equipment

INTERIOR WALLS AND CEILINGS
UNIT III

JOB SHEET #3 — INSTALL FURRING STRIPS ON A MASONRY WALL

I. Tools and equipment

- A. Folding rule or steel tape
- B. Try square
- C. Hammer and masonry nails
- D. Power handsaw and extension cord
- E. Chalk line
- F. 1" × 2" furring strips
- G. Powder-actuated fastener, pins, and manufacturer's instruction booklet

II. Procedure

(NOTE: When all furring strips are installed and aligned, the wall is ready for paneling.)

- A. Install furring strip at floor line
  1. Measure and cut furring strip to fit horizontally on wall at floor line
  2. Nail furring strip in place, using powder-actuated fastener or hammer and masonry nails

CAUTION

Do not use powder-actuated fastener until you have received your qualified operator's card. If you use fastener, enforce all safety rules and precautions.

JOB SHEET #3

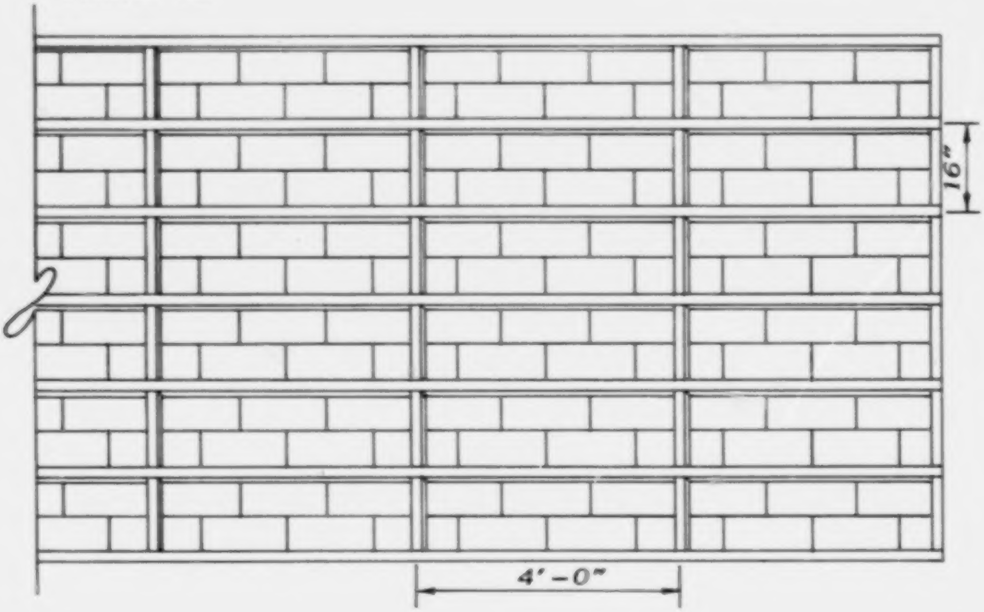
B. Lay out wall for horizontal furring strips spaced 16 inches on center starting from floor line (Figure 32)

C. Nail all horizontal furring strips in place

D. Cut and nail vertical furring strips between horizontal strips in all corners and centered every 4 feet (Figure 32)

(NOTE: The vertical strips are necessary to support the panel edges.)

FIGURE 32



E. Use a straightedge or string line to check alignment of furring strips; place shims behind furring strips if necessary

F. Clean area and put away all tools and equipment

INTERIOR WALLS AND CEILINGS
UNIT III

JOB SHEET #4 — INSTALL CEILING TILE OVER DRYWALL

I. Tools and equipment

  A. Folding rule or steel tape

  B. Chalk line

  C. Utility knife

  D. Straightedge

  E. Pointing trowel or caulking gun

  F. 12 × 12 ceiling tiles

  G. Adhesive

II. Procedure

(NOTE: The layout procedure in this job centers the installation on the center of the room, which may leave a very narrow border. This is generally not a problem for tile applied to drywall with adhesive; however, an alternate procedure which ensures that the border is no less than one-half of a tile wide is described in Job Sheet #5.)

  A. Mark center of each wall at ceiling

  B. Snap chalk line on ceiling between centers of two opposite walls

  C. Chalk another centerline at right angle to first centerline

  D. Starting at intersection of centerlines and working out toward walls, begin installing tiles, keeping tiles aligned to centerlines

  (NOTE: Some carpenters like to work from one side to the opposite side.)

    1. Use pointing trowel to place a small dab of adhesive on the bottom of each corner of each tile

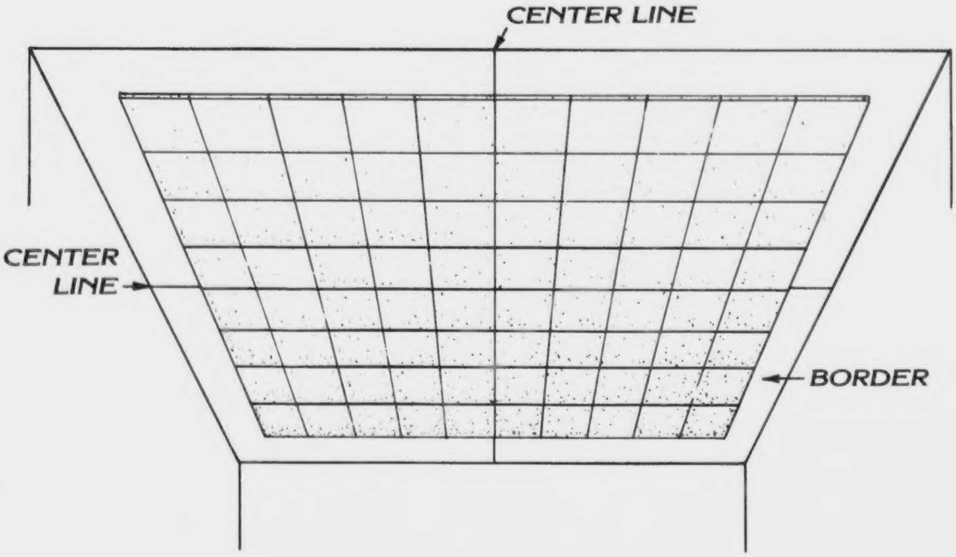
    2. Install each tile in position by pressing it to ceiling with a slight twist or sliding motion and then pulling back slightly and pushing it back into its proper position

    (NOTE: This procedure spreads the adhesive and ensures a good bond to the ceiling.)

  E. Continue installing tile until there is a border area too small for a whole tile (See Figure 33)

JOB SHEET #4

FIGURE 33



F. Install border tiles

1. Measure and scribe each tile to fit border width
2. Use utility knife and straightedge to score face of tile to measured width
3. Break tile over a sharp edge
4. Apply adhesive, following steps D-1 and D-2

G. Clean up area and put away tools and equipment

INTERIOR WALLS AND CEILINGS
UNIT III

JOB SHEET #5 — INSTALL FURRING STRIPS ON CEILING JOISTS AND CEILING TILE ON FURRING

I. Tools and equipment

- A. Folding rule or steel tape
- B. Chalk line
- C. Try square
- D. Hammer
- E. Straightedge
- F. Utility knife
- G. Power staple gun, staples, and manufacturer's instructions
- H. Power handsaw and extension cord
- I. Jigsaw
- J. 1" × 4" furring strips
- K. Ceiling tile and manufacturer's instructions
- L. 8d common nails

II. Procedure

- A. Determine layout of furring strips
  1. Lay out furring strips at right angles to joists
  2. Measure width or length of room along joists
  3. Divide length of joist exposure by width of tile to determine width of border tiles

     (NOTE: The width of the border tile will be one-half the remainder found in step 3, but must be at least one-half the width of a tile.)

JOB SHEET #5

EXAMPLE: If an installation is 17′-4″ wide and uses 12″ x 12″ ceiling tile, the border would be 8 inches, or

17′-4″ ÷ 1′-0″ = 17 with a remainder of 4″

Since 4″ ÷ 2 is less than one-half the width of one tile, add half the width of a tile, or

2″ + 1/2 (12″) = 8″ border.

B. Install furring strips

(NOTE: It may be necessary to install nailing blocks along sidewalls of installation if joists do not run along walls.)

1. Install first two furring strips perpendicular to joists along one wall so that second strip is centered along width of border tile
2. Use one nail in each joist and at the end of each strip
3. Cut furring strips so that splices are centered on joists
4. Install first and second furring strips on opposite wall, following procedure in step 1
5. Install remaining furring strips centered on intervals the width of full tiles

C. Lay out tile installation

1. Determine width of border tiles along end walls, using procedure described in step A-3
2. Mark width of end border tile plus width of tile flange out from end wall at each end of furring strip
3. Snap a chalk line between marks
4. Mark width of side border tile plus width of flange out from sidewall
5. Snap a chalk line at this mark square to first chalk line

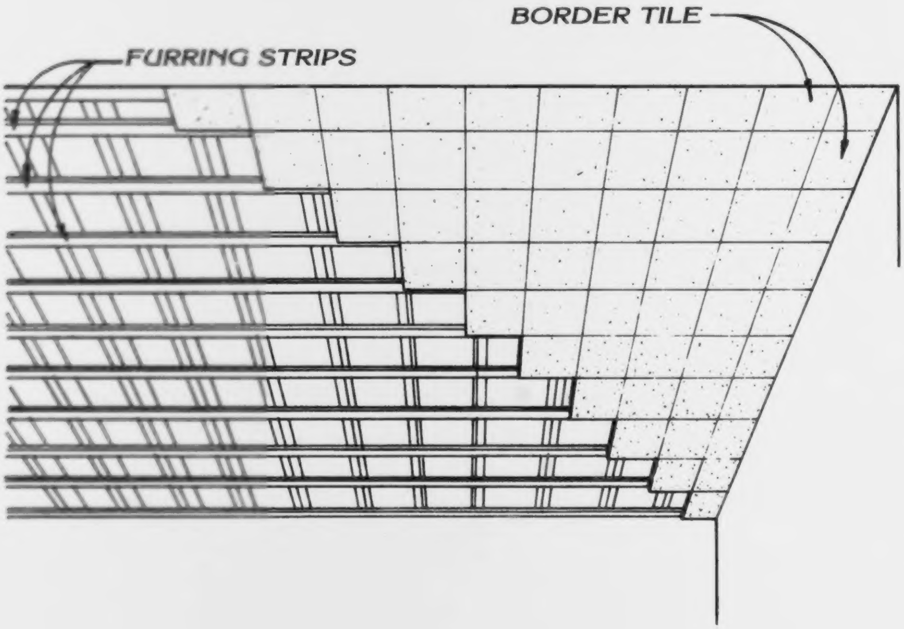
D. Install tile

1. Begin installation in corner at intersection of chalk lines
2. Cut first border tile to fit in corner with flanges aligned with chalk lines
3. Staple tile in place following manufacturer's recommendations regarding size, number, and placement of staples

JOB SHEET #5

4. Continue installing tiles using a stair-step pattern and frequently checking alignment (Figure 34)

FIGURE 34


BORDER TILE
FURRING STRIPS

5. Measure and trim border tiles as required during installation

E. Clean up area and put away tools and equipment

INTERIOR WALLS AND CEILINGS
UNIT III

JOB SHEET #6 — ERECT A SUSPENDED CEILING SYSTEM

I. Tools and equipment

   A. 100 foot tape

   B. Folding rule or steel tape

   C. Chalk line

   D. Claw hammer

   E. Laser instrument and rod

   F. 4 foot level

   G. Metal snips

   H. Side cut pliers

   I. End cut nippers

   J. Pop rivet gun and rivets

   K. Nails

   L. Wall angles (wall molding or L molding)

   M. 12 gauge hanger wires

   N. 12-foot main runners (main tees)

   O. 2-foot cross tees

   P. 2-foot × 2-foot ceiling panels

   Q. Plans

II. Procedures

   A. Layout ceiling height and center lines

   (NOTE: For clarity, the procedures give examples for a room 10′ –4″ × 14′ –8″. Adjust procedures as required for actual dimensions of installation.)

   1. Check plans to determine finish ceiling height and size of ceiling panels

JOB SHEET #6

2. Use laser instrument to establish proper ceiling height around perimeter of walls and mark

3. Snap chalk lines through all marks continuously around walls

4. Recheck lines to be sure all are level and at proper height

5. Accurately measure length of all walls and check corners for square

6. Determine layout of runners and tees from size of room and size of tile to be installed

   (NOTE: If ceiling size is odd foot dimensions or if walls are not exactly parallel, use centerline of the room to establish layout.)

7. Measure and mark centerline of two end walls (5′ – 2″) then measure and mark centerline of two sidelines (7′ – 4″).

   (NOTE: Ceiling will take 6 full tiles plus two 16″ border tiles lengthwise and 4 full tiles plus two 14″ border tiles across its width.)

B. Install wall angles (See Figure 35)

1. Nail wall angles to wall along the established chalkline overlapping angles at inside corners

   (NOTE: Angles should be mitered where they meet at outside corners. On inside corners some installers cut a miter on the bottom angle so that the corner appears to be mitered.)

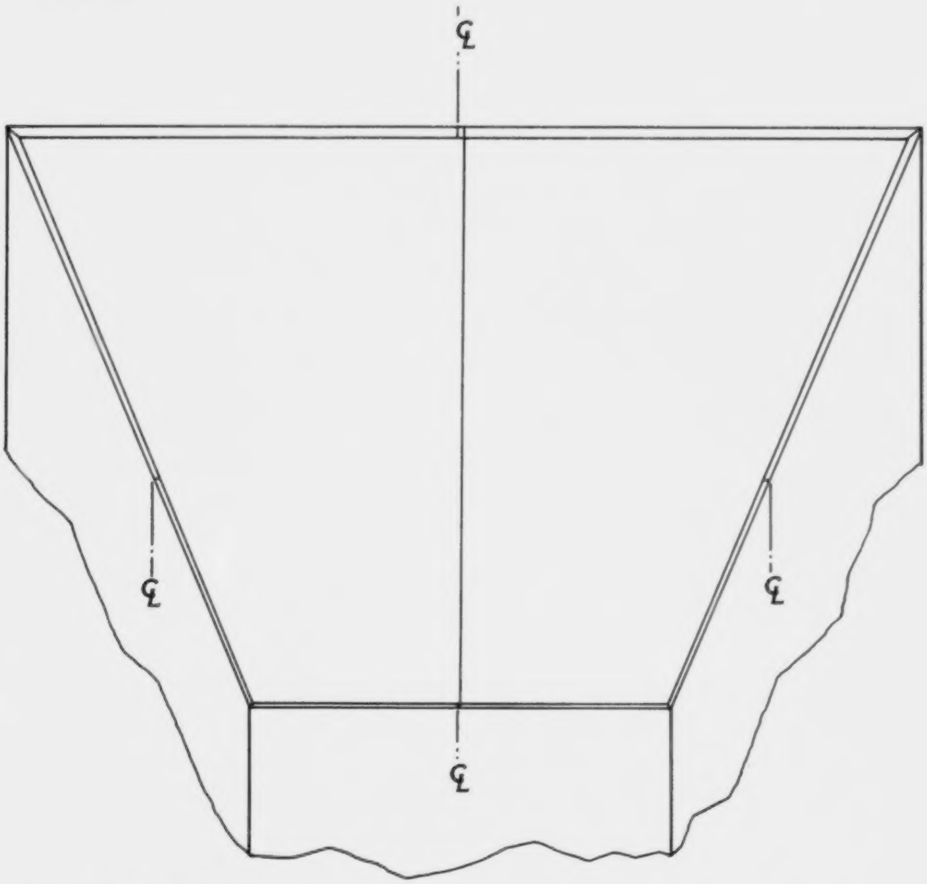
2. Transfer centerline marks from wall to the wall angles

3. Measure over one-half the width of main runner from centerline on both short walls

4. Attach string line to wall at this mark and stretch it tight to mark on opposite wall, at ceiling level

JOB SHEET #6

FIGURE 35



C. Install hanger wire

1. Install hanger wires to structure above, spaced to 48" o.c. along main beams and within 6" of ends of main beams and let wires hang straight down

2. Establish proper ceiling height on wires (allowing for height of main runner) and bend wires at this point

D. Install main runners

1. Install first main runner by positioning runner at proper ceiling height and securing with hanger wires

2. Align runner with string line so that it will center on centerline

   (NOTE: Be sure to fit main runners properly together so that cross tee slots are properly aligned.)

JOB SHEET #6

3. Working from first main runner install remainder of tees centered on two foot centers.

4. Remove string line

E. Install cross tees

1. Layout for center cross tees by following steps 2 through 4 in section B

2. Install cross tees starting in the center along string line

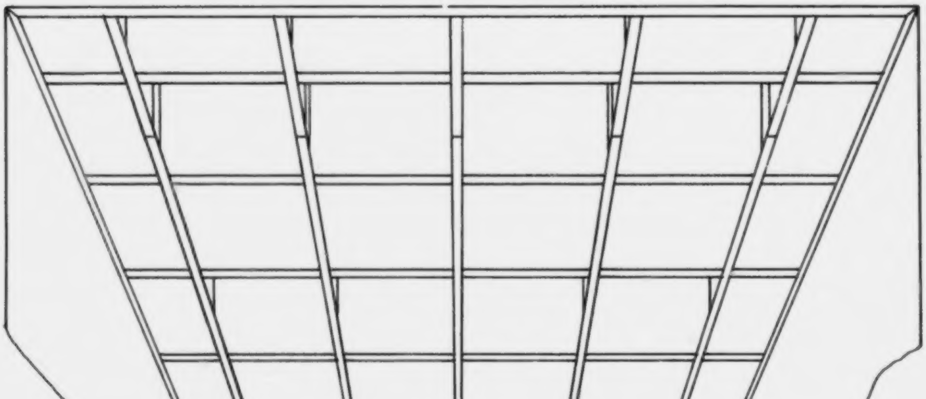
3. Fit ends of cross tees into slots on main runners

   (NOTE: Be sure ends of cross tees are properly inserted and locked in place.)

4. Continue installing remainder of cross tees until grid is completed

5. Check completed grid to be sure all runners and tees are level and straight (Figure 36)

FIGURE 36

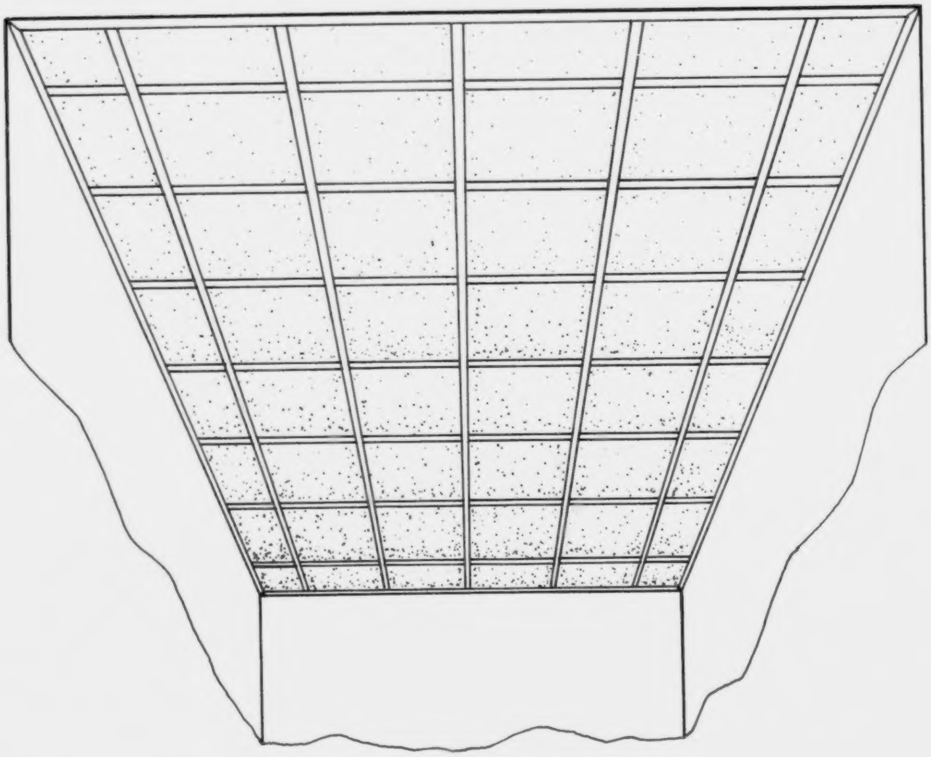


JOB SHEET #6

F. Complete ceiling (Figure 37)

1. Install ceiling panel
2. Check to see that ceiling is properly installed

FIGURE 37



G. Clean work area and put away tools and equipment

INTERIOR WALLS AND CEILINGS
UNIT III

JOB SHEET #7 — INSTALL DOOR TRIM

I. Tools and equipment

   A. Radial arm or table saw

   B. Power miter saw or sawbuck and extension cord

   C. Handsaw

   D. Claw hammer

   E. Try square

   F. Folding rule or steel tape

   G. Nail set

   H. Adhesive and manufacturer's instructions

   I. Putty stick

   J. 4d, 6d, and 8d finish nails

   K. Door casing

II. Procedures

   A. Install door framing

      1. Select casing for the opening

      2. Mark and cut casing

      3. Check head casing to see that it will fit properly

      4. Cut miter on one end of both side casings

      5. Turn side casing upside down; hold in place and mark cutoff position

         (NOTE: Position of the cut should be $^{3}/_{16}$ inch above the bottom edge of the door header jamb. This allows for the reveal.)

      6. Follow same procedure to mark second side casing

      7. Use power miter saw or sawbuck to make the miter cuts on the casing

      8. Temporarily nail head casing in place with 8d finish nails

JOB SHEET #7

9. Install side casing
   a. Place a small amount of glue on the two miters
   b. Nail in place

      (NOTE: Be sure to remove any excess glue with a damp cloth.)
10. Drive all nails in and complete nailing
    a. Use 4d or 6d nails, spaced about 16 inches apart, along inside edge
    b. Use 8d finish nails, spaced about 16 inches apart, along outside edge
11. Use nail set to set all exposed nail heads in the frame and casing

B. Install doorstops

1. Measure and cut side stops to size
2. Miter top end of each side stop

   (NOTE: Be sure that miter cuts run down to inside of stop.)
3. Close door
4. Set stop for lock side tight against the door and nail in place with a 4d finish nail near each end and at 16-inch intervals
5. Set stop for hinge side with a 1/16 inch clearance and nail in place with a 4d finish nail near each end and at 16-inch intervals
6. Measure and cut head stop to size
7. Miter each end of head stop
8. Align head stop with the two stops and nail in place with 4d finish nails near each end and at 16-inch intervals
9. Use nail sets to set all nails in the door unit
10. Use putty stick to fill all nail holes

C. Clean work area and put away tools and equipment

INTERIOR WALLS AND CEILINGS
UNIT III

JOB SHEET #8 — INSTALL WINDOW TRIM

I. Tools and equipment

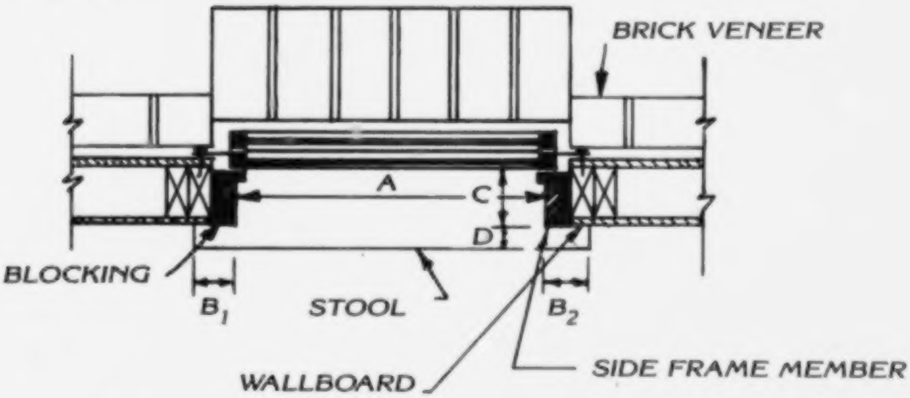
- A. Radial arm or table saw
- B. Power miter or sawbuck and extension cord
- C. Handsaw
- D. Claw hammer
- E. Try square
- F. Folding rule or steel tape
- G. Nail set
- H. Casing, stool, and material
- I. 4d, 6d, and 8d finish nails

II. Procedure

- A. Install stool
  - 1. Lay out and cut to size (Figure 38)
    - a. Measure distance between the side jambs (dimension A)
    - b. Add dimensions B_1 and B_2 as specified to dimension A for length of stool
    - c. Measure distance from the window unit to the inside edge of the side frame for dimension C
    - d. Add dimension D to dimension C for width of the stool

      (NOTE: Dimension D will depend on window style.)

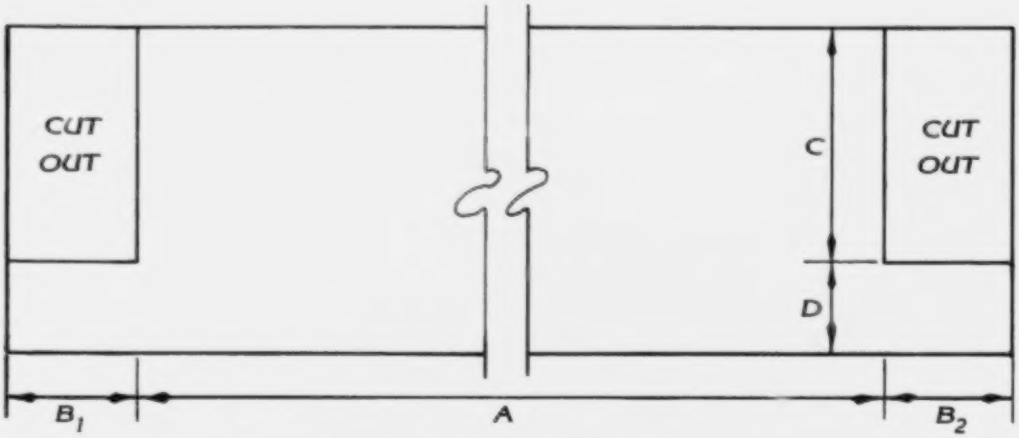
FIGURE 38



JOB SHEET #8

e. Lay out stool and cut (Figure 39)

FIGURE 39


CUT OUT
CUT OUT
C
D
B_1
A
B_2

2. Install and nail stool in place, using 8d finish nails

   (NOTE: Use shims to raise sill to proper height; sill must fit snugly between frames and the window unit.)

B. Case window

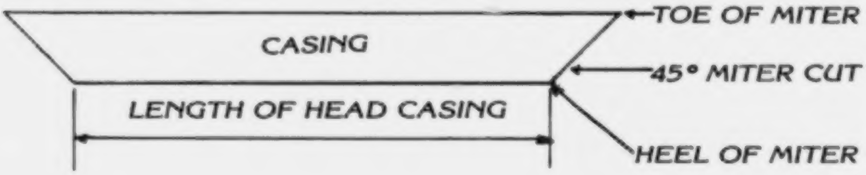
1. Cut head casing (Figure 40)

   a. Measure distance between the side frames

   b. Add 3/8 inch for the 3/16 inch reveal on both side frames

   (NOTE: This is the measurement for the heel of the 45-degree cuts.)

FIGURE 40


TOE OF MITER
CASING
45° MITER CUT
LENGTH OF HEAD CASING
HEEL OF MITER

2. Cut casing for sides (See Figure 41)

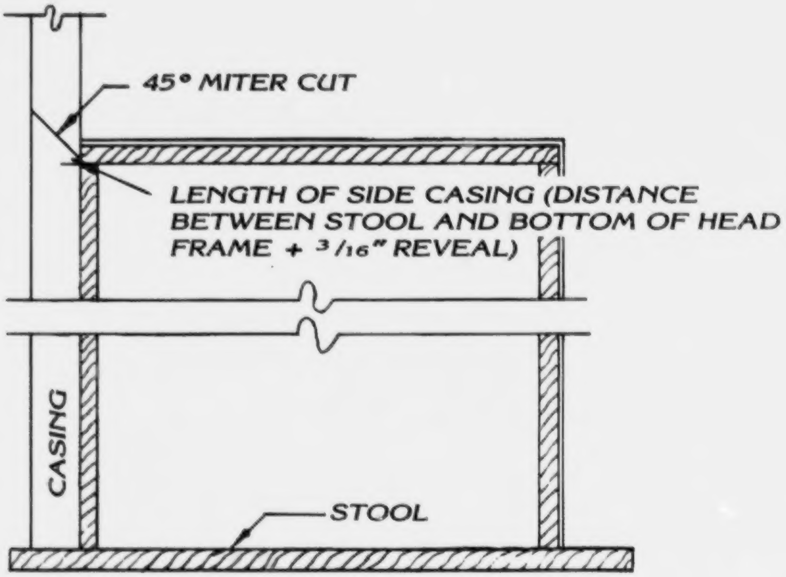
   a. Measure from top of stool to bottom face of head frame

   b. Add 3/16 inch for the reveal on the frame

JOB SHEET #8

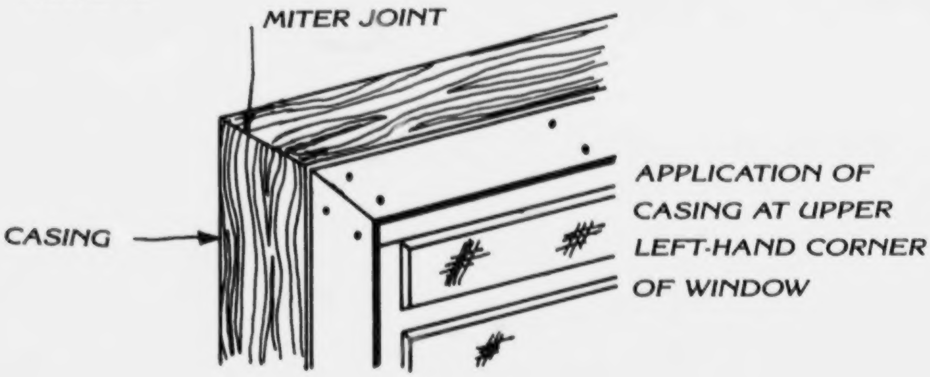
c. Cut two sides for window

FIGURE 41


45° MITER CUT
LENGTH OF SIDE CASING (DISTANCE BETWEEN STOOL AND BOTTOM OF HEAD FRAME + 3/16" REVEAL)
CASING
STOOL

3. Install casing (Figure 42)

FIGURE 42


MITER JOINT
CASING
APPLICATION OF CASING AT UPPER LEFT-HAND CORNER OF WINDOW

NOTE TIGHT FIT OF MITER JOINT

(NOTE: Be sure miter fits tight all the way across.)

a. Check head casing to see that it fits properly

JOB SHEET #8

b. Nail side casings temporarily in place with 6d finish nails

c. Place small amount of glue on miter joints, then nail head casing with 6d nails near ends and spaced 16 inches between

d. Wipe excess glue from miters with a damp cloth

e. Drive nails unitl heads are about $^1/_{16}$ inch above casing

f. Use nail set to drive nails final distance

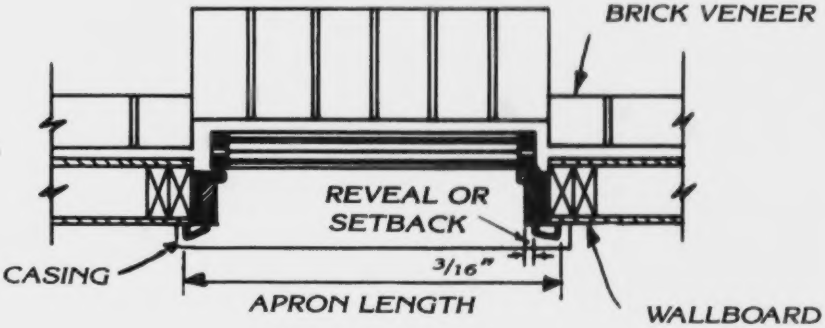
(NOTE: It is advisable to drill nail holes in all casing and trim when using hardwoods.)

C. Cut and install apron

(NOTE: Apron lengths should be equal to the distance between outside edges of side casing.)

1. Measure distance between the outside edges of the side casing (Figure 43)

FIGURE 43



2. Transfer measurement to the apron

3. Cut apron to length

4. Miter or shape ends

JOB SHEET #8

5. Nail in place directly under the stool, using 6d finish nails (See Figure 44 and 45)

FIGURE 44

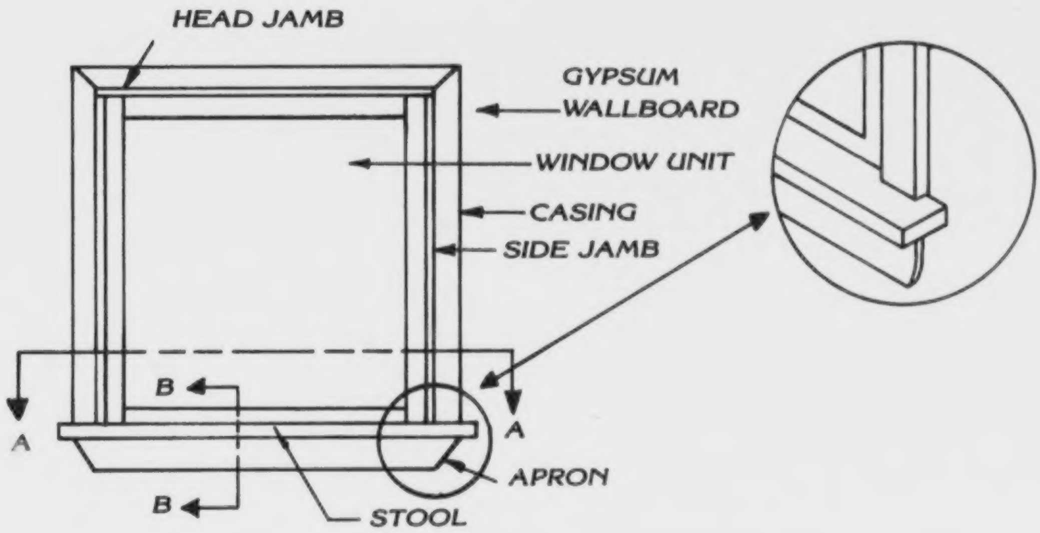
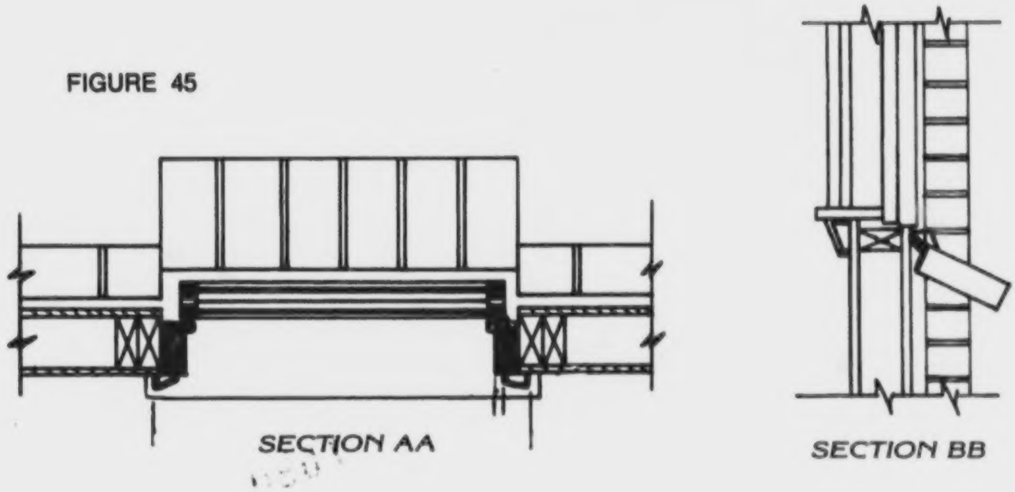

HEAD JAMB
GYPSUM WALLBOARD
WINDOW UNIT
CASING
SIDE JAMB
B
A
A
B
APRON
STOOL

FIGURE 45


SECTION AA

SECTION BB

D. Clean work area and put away tools and equipment

INTERIOR WALLS AND CEILINGS
UNIT III

TEST

NAME ________________________________ SCORE ______________

1. Match to their correct definitions terms associated with wall and ceiling finishes. Write the correct numbers in the blanks.

______a. Glue, cement, mastic, paste, or any substance capable of holding materials together by surface attachment

______b. Hardboard (usually with gypsum core) used to cover walls and ceilings

______c. Strips of wood or metal applied to surface to make it straight and plumb and to provide fastening surface for finish covering

______d. Mixture of lime, cement, and sand applied to walls and ceilings to finish their surfaces

______e. Thin sheet of hard, smooth, synthetic material that is highly resistant to scratching and wear; used for wainscoting and wall paneling

______f. Material used to fill holes in finished surface; is color-coded to match finished surface

______g. Tool with a sharp point used to make irregular marks for cutting and fitting a piece of material

______h. Material that covers lower part of an interior wall surface and contrasts with wall surface above

______i. Trim nailed to wall at top edge of wainscoting

______j. Metal, wood, or gypsum panel nailed to stud as backing or base for plaster

______k. To cut or shape the end of a piece of molding so that it will fit the contour of an adjoining piece of molding

1. Lath
2. Scribe
3. Casing
4. Putty stick
5. Wainscot
6. Doorstop
7. Plastic laminate
8. Base
9. Cope
10. Cap molding
11. Batten
12. Drywall
13. Adhesive
14. Furring
15. Astragal
16. Plaster

TEST

_____l. Molding strip on door frame that keeps the door from swinging through

_____m. Framework of trim of various widths and thicknesses used around windows, doors, and other openings.

_____n. Finish molding covering bottom edge of wall material where the wall and floor meet

_____o. Molding trim attached to inside edge of one of 2 pair of doors or windows to prevent swinging through; also used with sliding doors to ensure tighter fit where doors meet

_____p. Narrow strips of wood or metal trim used to cover joints of sheathing, paneling, or other materials to seal the joints.

2. List three types of partition walls used in commercial structures.

a. ______________________________

b. ______________________________

c. ______________________________

3. List materials used to finish walls and ceilings.

Walls (List four.)

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

Ceilings (List three.)

a. ______________________________

b. ______________________________

c. ______________________________

TEST

4. Name styles of paneling.

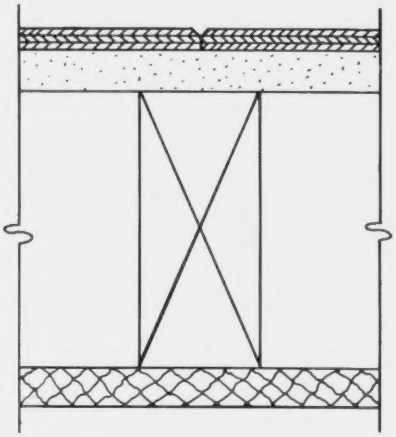
a. ______________________________

b. ______________________________

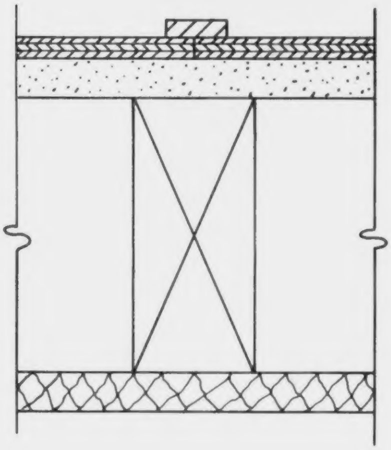
c. ______________________________

5. Identify the following illustrations of top views of joint treatments for paneling. Write the correct names in the blanks.

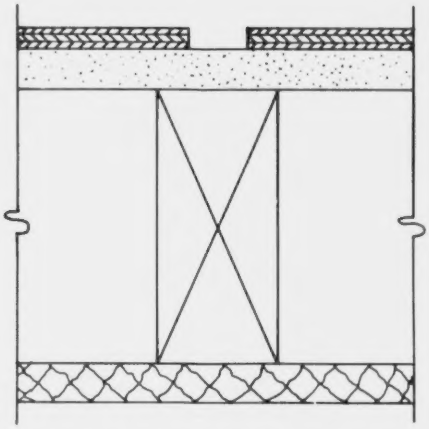
Batten strip **Open joint** **Butt joint with V-groove**



a. ______________________________



b. ______________________________



c. ______________________________

TEST

6. Estimate the number of 4′ × 8′ sheets needed to panel the office area, reception room and the supply room illustrated on the floor plan below. Write the correct answers in the blanks.

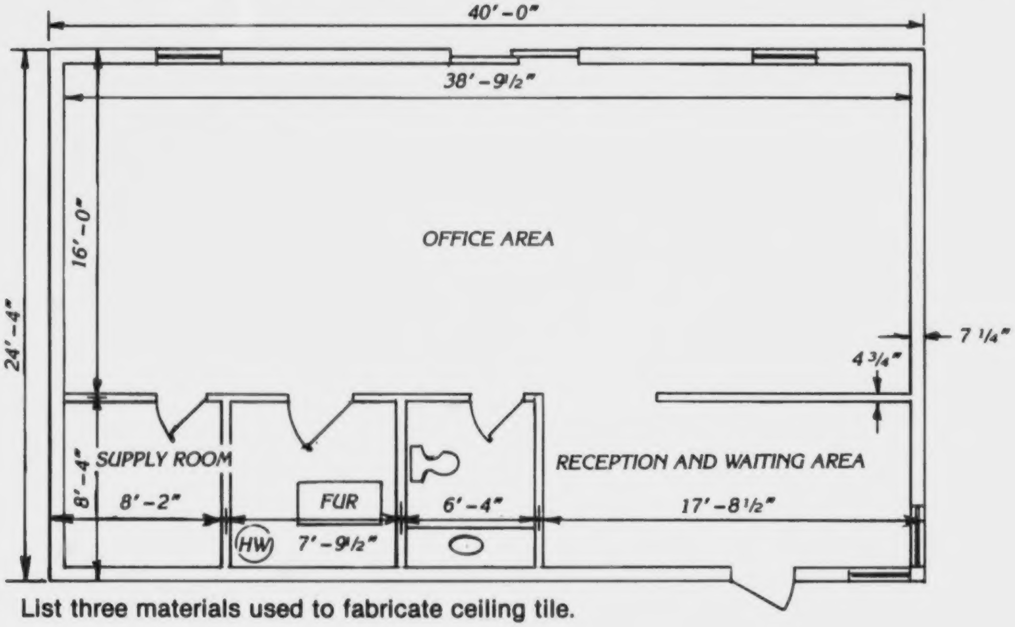
   a. Perimeter of office area = ______________________

   b. Perimeter of reception room = ______________________

   c. Perimeter of supply room = ______________________

   d. Total lineal feet of wall = ______________________

   e. Total number of 4′ × 8′ sheets needed = ______________________


40′-0″
38′-9½″
16′-0″
OFFICE AREA
24′-4″
7 ¼″
4 ¾″
SUPPLY ROOM
8′-4″
8′-2″
FUR
HW
7′-9½″
6′-4″
RECEPTION AND WAITING AREA
17′-8½″

7. List three materials used to fabricate ceiling tile.

   a. ______________________

   b. ______________________

   c. ______________________

8. List four factors that influence type of ceiling tile to be used.

   a. ______________________

   b. ______________________

   c. ______________________

   d. ______________________

TEST

9. Estimate the number of ceiling tiles needed to finish ceilings with the dimensions given below. Each tile will cover one square foot. Write the correct answers in the blanks and show your work in the spaces provided.

   a. How many tiles will be needed for a room that is 16'-8" × 20'-6"?

      Number of tiles = ______________________________

   b. How many tiles will be needed for a room that is 17'-6" × 26'-0"?

      Number of tiles = ______________________________

   c. How many tiles will be needed for a room that is 9'-10" × 19'-0"?

      Number of tiles = ______________________________

TEST

10. Name three types of suspended ceiling systems.

a. ______________________________

b. ______________________________

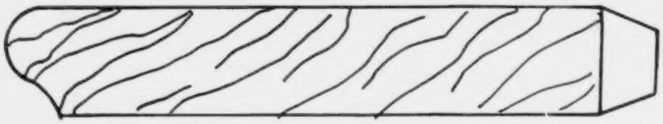
c. ______________________________

11. Identify types of interior trim. Write the correct names in the blanks.

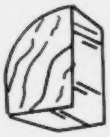
Base
Outside corner
Shoe molding (base shoe)
Cap molding (cap strip)
Casing

T-astragal
Chair rail
Batten
Doorstop molding
Cove

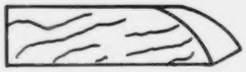
Inside corner
Quarter round
Crown
Window stool



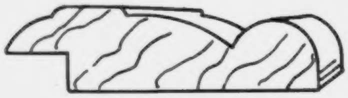
a. ______________________________



b. ______________________________



c. ______________________________



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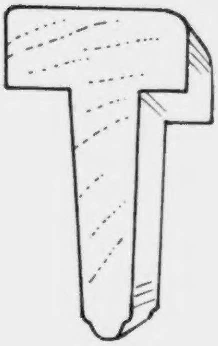

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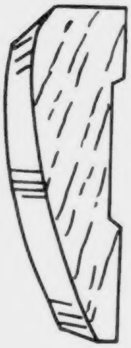

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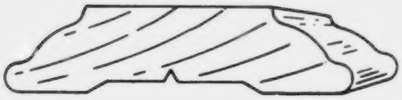

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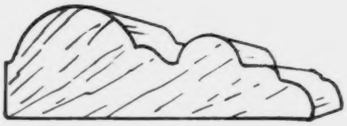

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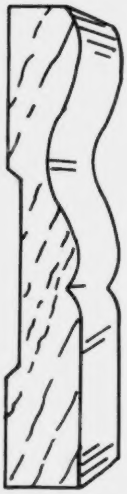

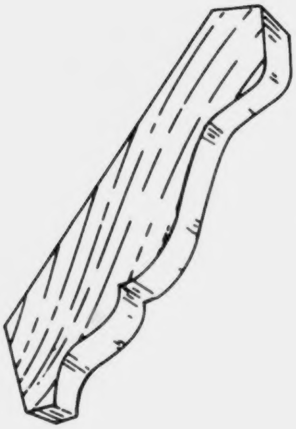

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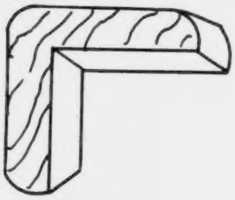

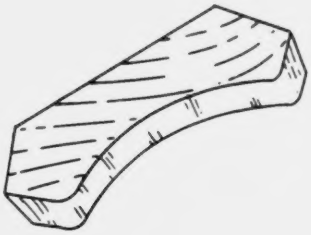

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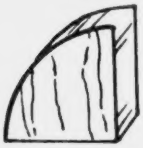
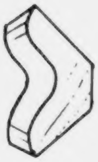


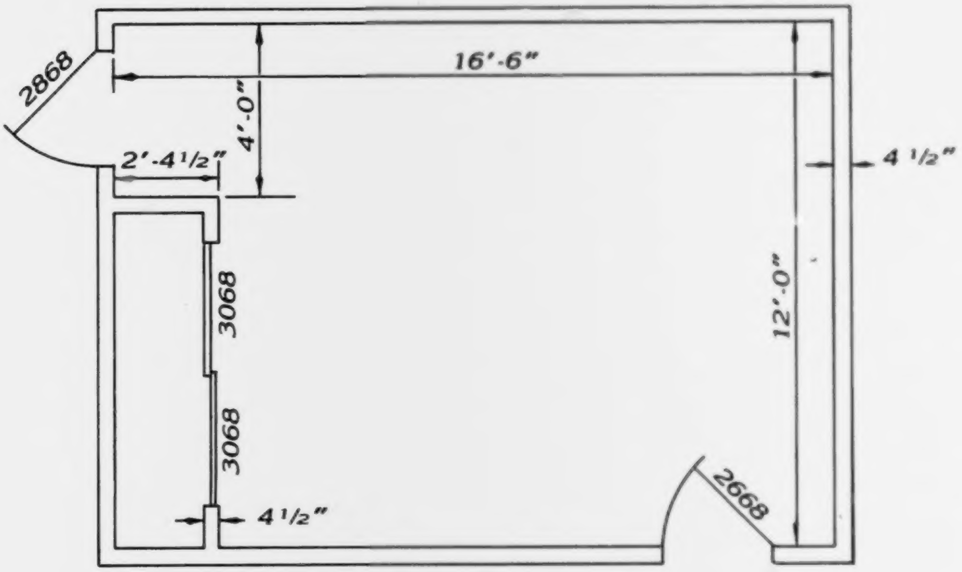


m. ______________________________

n. ______________________________

TEST

12. Estimate material needed to trim inside the room illustrated.



Use the following trim items: 5/8" × 3 1/2" colonial base; 5/8" × 2 1/2" colonial casing; 7/16" × 3/4" shoe molding; 1" × 1" outside corner molding; 7/16" × 1 3/8" O.G. doorstops; 9/16" × 3 1/4" WP51 crown molding.

a. Casing
   1. Type and size____________
   2. Number ____________

b. Door stops
   1. Type and size____________
   2. Number____________

c. Base
   1. Type and size____________
   2. Number of feet____________

d. Shoe mold
   1. Type and size____________
   2. Number of feet____________

e. Crown mold
   1. Type and size____________
   2. Number of feet____________

f. Outside corners
   1. Type and size____________
   2. Number____________

TEST

(NOTE: Test question 13 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

13. Demonstrate the ability to

    a. Install V-grooved paneling and trim.

    b. Install panel wainscot and trim.

    c. Install furring strips on a masonry wall.

    d. Install ceiling tile over drywall.

    e. Install furring strips on ceiling joists and ceiling tile on furring.

    f. Install a suspended ceiling system.

    g. Install door trim.

    h. Install window trim.

INTERIOR WALLS AND CEILINGS
UNIT III

ANSWERS TO TEST

1. a. 13
   b. 12
   c. 14
   d. 16
   e. 7
   f. 4
   g. 2
   h. 5
   i. 10
   j. 1
   k. 9
   l. 6
   m. 3
   n. 8
   o. 15
   p. 11

2. Answer should include the following

   a. Permanent
   b. Movable
   c. Operable

3. **Walls** (Answer should include any four of the following.)

   a. Plaster
   b. Drywall
   c. Solid-lumber paneling
   d. Plywood paneling
   e. Plastic laminate
   f. Hardboard paneling
   g. Ceramic tile

   Ceilings (Answer should include any three of the following.)

   a. Plaster
   b. Drywall
   c. Drywall with exposed beams
   d. Ceiling tile
   e. Exposed roof-deck and beams

4. a. V-grooved
   b. Plain
   c. Brushed

5. a. Butt joint with V-groove
   b. Batten strip
   c. Open joint

6. (NOTE: Answers will vary due to methods of estimating.)

   a. 110′
   b. 50′
   c. 32′
   d. 192
   e. 48 sheets

ANSWERS TO TEST

7. Answer should include any three of the following
   - a. Fiberboard
   - b. Mineral
   - c. Perforated metal
   - d. Glass fiber
   - e. Mirror

8. Answer should include any four of the following
   - a. Appearance
   - b. Initial cost
   - c. Ease of installation
   - d. Light reflection
   - e. Fire resistance
   - f. Sound absorption
   - g. Maintenance cost
   - h. Insulation value

9. (NOTE: Answers will vary due to methods of estimating.)
   - a. 357
   - b. 468
   - c. 190

10. Answer should include any three of the following
    - a. Exposed grid systems
    - b. Semi-concealed grid systems
    - c. Concealed grid systems
      1. Zee bar
      2. Tee
      3. Double leaf access
    - d. Inegrated system
    - e. Suspended drywall furring system

11.
    - a. Window stool
    - b. Shoe molding (base shoe)
    - c. Doorstop molding
    - d. Cap molding (cap strip)
    - e. T-astragal
    - f. Casing
    - g. Batten
    - h. Chair rail
    - i. Base
    - j. Crown
    - k. Outside corner
    - l. Cove
    - m. Quarter round
    - n. Inside corner

ANSWERS TO TEST

12. Answer should include the following
    (NOTE: Because estimating answers will vary considerably, answers should be evaluated to the satisfaction of the instructor.)

    a. Casing
        1. Colonial 5/8" × 2 1/2"
        2. One set for each swinging door frame
           Two sets for sliding door frame

    b. Door stops
        1. O.G. 7/16" × 1 3/8"
        2. One set for each door frame

    c. Base
        1. Colonial base 5/8" × 3 1/2"
        2. 60 lineal feet

    d. Shoe mold
        1. 7/16" × 3/4"
        2. 60 lineal feet

    e. Crown mold
        1. WP51 Crown 9/16 × 3 1/4"
        2. 58 lineal feet

    f. Outside corner
        1. 1" × 1" × 8'
        2. 1 piece

11. Performance skills evaluated to the satisfaction of the instructor.

EXTERIOR DOORS AND HARDWARE
UNIT IV

UNIT OBJECTIVE

After completing this unit, the student should be able to install a complete entry including threshold, frame, door, hardware, trim, and weatherstripping. The student will show this knowledge by completing the job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with exterior doors to their correct definitions.
2. State basic classifications of exterior doors.
3. Identify types of entry doors.
4. Identify parts of an exterior door installation.
5. List materials used in door construction.
6. Name materials used for exterior doorsills.
7. Select from a list standard sizes of commercial doors.
8. Explain the numbering system for doors.
9. Complete statements about recommended finish clearances and dimensions for hanging doors.
10. Identify door swing (hand).
11. Identify exterior doors and miscellaneous hardware.
12. Demonstrate the ability to
    a. Install a metal threshold on a concrete floor.
    b. Install an exterior prehung door unit.
    c. Install entry door frame, casing, door, and lock.
    d. Install bronze weatherstripping.
    e. Install door frame and inside jambs for an overhead door.

EXTERIOR DOORS AND HARDWARE
UNIT IV

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency masters

    1. TM #1 — Parts of a Typical Exterior Door Installation

    2. TM #2 — Types of Entry Doors

    3. TM #3 — Types of Entries

  D. Information sheet

  E. Job sheets

    1. Job Sheet #1 — Install a Metal Threshold on a Concrete Floor

    2. Job Sheet #2 — Install an Exterior Prehung Door Unit

    3. Job Sheet #3 — Install Entry Door Frame, Casing, Door, and Lock

    4. Job Sheet #4 — Install Bronze Weatherstripping

    5. Job Sheet #5 — Install Door Frame and Inside Jambs for an Overhead Door

  F. Test

  G. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain materials to supplement unit.

    1. Examples of various doors

    2. Examples of materials used in door and doorsill construction

    3. Cut-away models of various exterior doors (if possible)

    4. Door jig for demonstration purposes

    5. Samples of various types of exterior door hardware

    6. Equipment and materials for job sheet procedures

SUGGESTED ACTIVITIES

7. Transparencies and competency profiles

   (NOTE: Transparencies and competency profiles for this manual are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from the The Associated General Contractors of America, 1975 E Street N.W., Washington, D.C. 20006; phone 202-393-2040.)

C. Provide students with unit.

D. Introduce unit.

SUGGESTIONS:

- Have students name as many exterior doors as they can.

  EXAMPLES: Entry, patio, overhead garage, heated-to-unheated passage, storm

- Have students name as many purposes of exterior doors as they can.

  EXAMPLES: Access, security, view, insulation, decorative accent

- Use pictures from magazines and trade manuals to make a bulletin board display of exterior doors.
- Discuss the emphasis placed on main entry doors as a first impression on visitors; provide illustrations from decorator magazines. Using plans and specifications, discuss the variety exterior doors shown.
- Discuss unit and specific objectives, relating them to your introduction of the unit.

E. Discuss information sheet.

1. Use Information Sheet, Section I to introduce terms associated with exterior doors.

   SUGGESTIONS:

   - Show students examples of appropriate terms.
   - Use Transparency #1 or actual door to point out appropriate terms.

2. Use Information Sheet, Section II to discuss basic classifications of exterior doors.

   SUGGESTIONS:

   - Provide students with plans showing each type of door.

     (NOTE: Be sure to emphasize the variety of applications for each type. For example, point out that a garage door may be any of the four classes.)

SUGGESTED ACTIVITIES

- Take students on a tour of the community so that they may see buildings with a variety of examples of the five door classifications.

3. Use Information Sheet, Section III to discuss types of entry doors.

   SUGGESTIONS:

   - Use Transparency #2 to illustrate your discussion.
   - Obtain literature about entry doors or have a manufacturer's or distributor's representative talk to the class about entry doors.
   - Use cut-away models to show door construction and panel and insert installations.

4. Use Information Sheet, Section IV to discuss exterior door installation.

   SUGGESTIONS:

   - Use Transparency #1 to illustrate typical exterior door installation.
   - Relate parts shown on entry door in Transparency #1 to other types of exterior door installations.
   - Use Transparency #3 to illustrate various entries
   - Mount a prehung door in an exposed, framed opening to show the installation; relate installation to previous units.
   - Emphasize proper fit of parts and the planning required to permit proper assembly.
   - Discuss installation variations, such as split jambs, rabbeted jambs, and the use of a doorstop.
   - Tour a door manufacturing plant or supplier to provide the students with an idea of the variety of installations and doors available.

5. Use Information Sheet, Sections V and VI to discuss materials used in door and doorsill construction.

   SUGGESTIONS:

   - Provide students with samples of materials and examples of doors using each type of material; use cut-away models if possible.
   - Discuss reasons for using or not using the materials in various applications; relate materials to classifications and types of doors previously covered.
   - Emphasize specific types of each material, such as the metals most commonly used in door construction.

SUGGESTED ACTIVITIES

- Discuss local uses, costs, and availability of doors constructed of various materials; point out local codes covering exterior door construction and materials.

- Use actual doors or manufacturers' literature to point out the use of combinations of these materials.

6. Use Information Sheet, Section VII to discuss standard exterior door sizes, emphasizing local regulations governing entry door sizes.

7. Use Information Sheet, Section VIII to explain the numbering system for doors.

8. Use Information Sheet, Section IX to discuss recommended finish clearances and dimensions for hanging doors.

   SUGGESTIONS:

   - Have a carpenter talk to the class about proper clearances.

   - Allow students to practice measuring dimensions and marking them with chalk on doors and frames or on door outlines on sheets of plywood.

   - Demonstrate the use of a door jig and allow students to practice.

9. Use Information Sheet, Section X to discuss door swing (hand).

   SUGGESTIONS:

   - Tie in previous sections to discuss the information needed to order a door.

   - Provide students with plans and have them write an order for the exterior doors specified in the plans. Have them specify construction, size, and hand for prehung units.

   - Demonstrate a memory aid to help students remember how to determine door hand.

   - Demonstrate the procedures in Job Sheet #2.

   - Have students complete Job Sheet #2.

10. Use Information Sheet, Section XI to discuss hardware used with exterior doors.

    SUGGESTIONS:

    - Provide students with samples of the various types of hardware, including thresholds, and discuss their applications.

SUGGESTED ACTIVITIES

- Discuss weatherstripping and then demonstrate the procedures in Job Sheet #4, using various types.
- Have students complete Job Sheet #4.
- Use cut-aways to show hardware construction; demonstrate operation and installation of hardware.
- Demonstrate the procedures in Job Sheets #1, #3, and #5, emphasizing local practices and regulations and different techniques.
- Have students complete Job Sheets #1, #3, and #5.

F. Review unit.

G. Give test.

H. Critique test and discuss in class.

I. Complete appropriate sections of competency profiles.

III. Unit references

A. Hepler, Donald E., and Paul I. Wallach. *Architecture Drafting and Design,* 3rd ed. New York: McGraw-Hill, 1977.

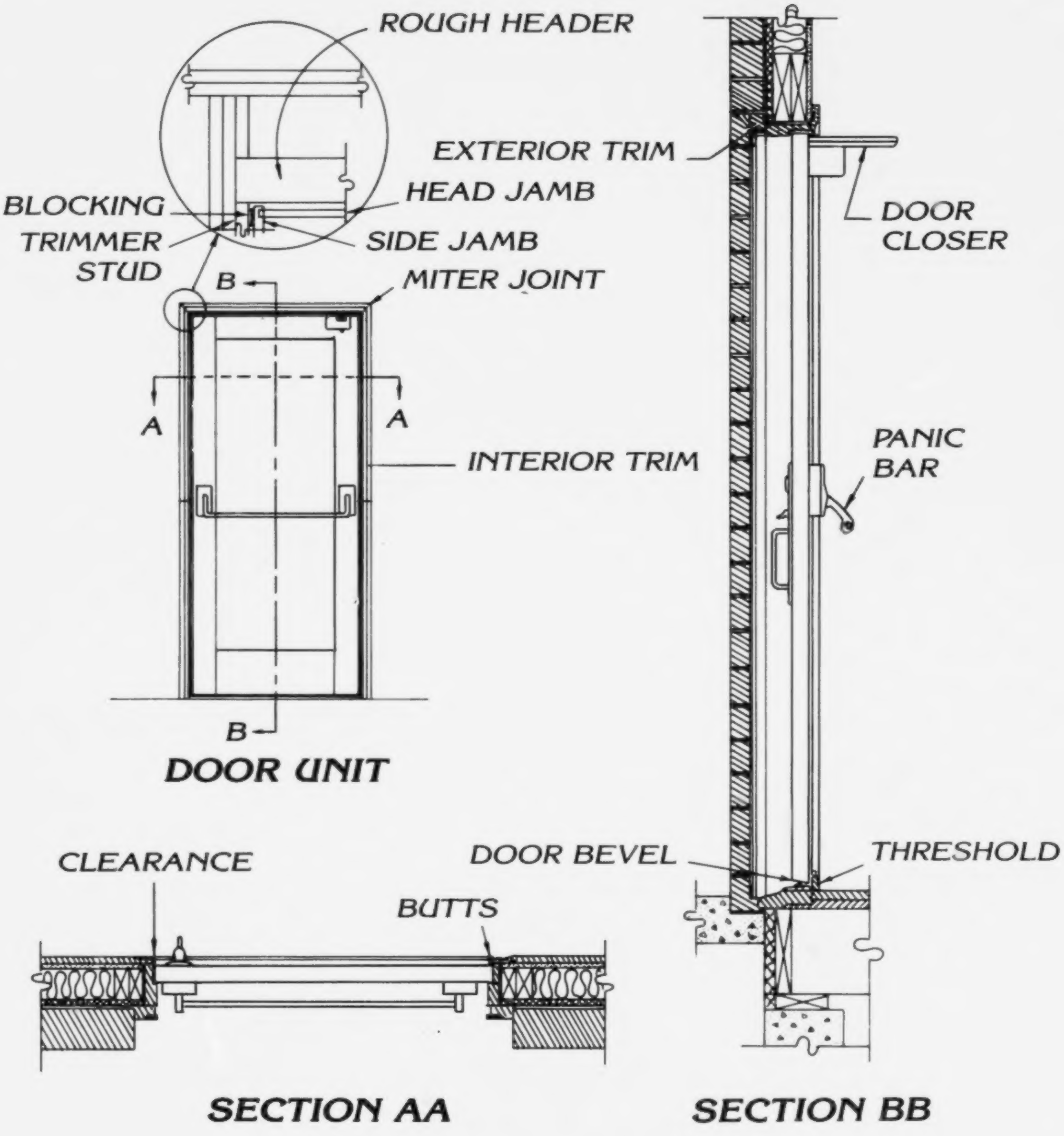
B. Ramsey, Charles G., and Harold R. Sleeper. *Architectural Graphic Standards,* 6th ed. Edited by Joseph N. Boaz. New York: John Wiley and Sons, Inc., 1970.

C. "Design a Grand Entry with Simpson," STC-1114. Seattle, Washington: Simpson Timber Company, 1982

D. Wagner, Willis H. *Modern Carpentry.* South Holland, Illinois: The Goodheart-Willcox Co., Inc., 1976.

E. Weshe Catalog. Tulsa, Oklahoma: Wesche Company Door and Hardware Catalog No. 84A.

Parts of a Typical Exterior Door Installation

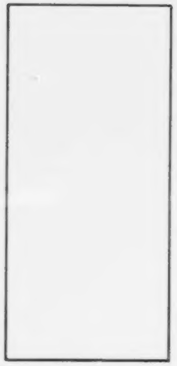

ROUGH HEADER
BLOCKING
TRIMMER STUD
HEAD JAMB
SIDE JAMB
B
MITER JOINT
A
A
INTERIOR TRIM
B
EXTERIOR TRIM
DOOR CLOSER
PANIC BAR
DOOR BEVEL
THRESHOLD
CLEARANCE
BUTTS

DOOR UNIT

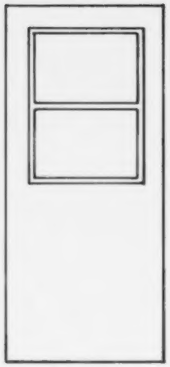
SECTION AA

SECTION BB

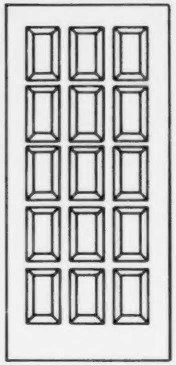
Types of Entry Doors
(Wood or Metal)



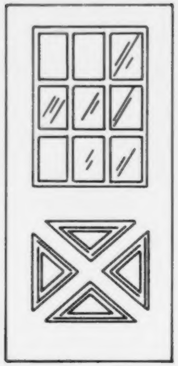
FLUSH



SASH

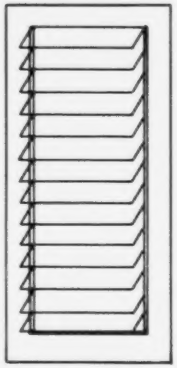


PANEL

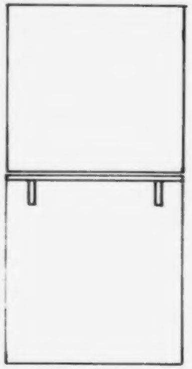


COMBINATION

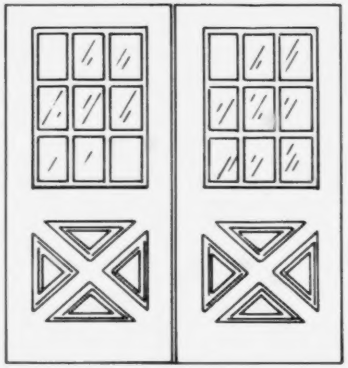
THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA



JALOUSIE

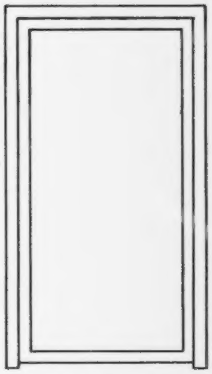


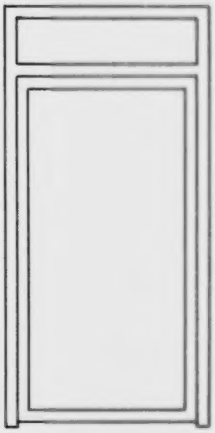
DUTCH

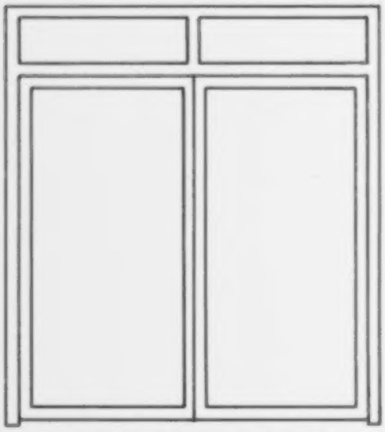


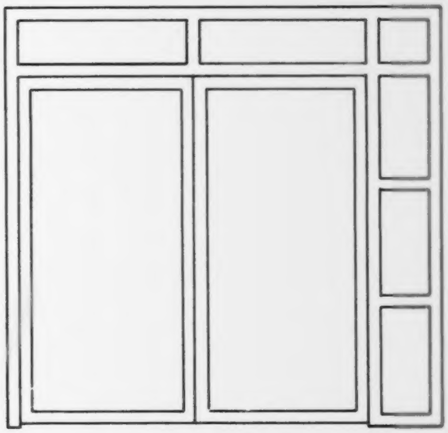
DOUBLE

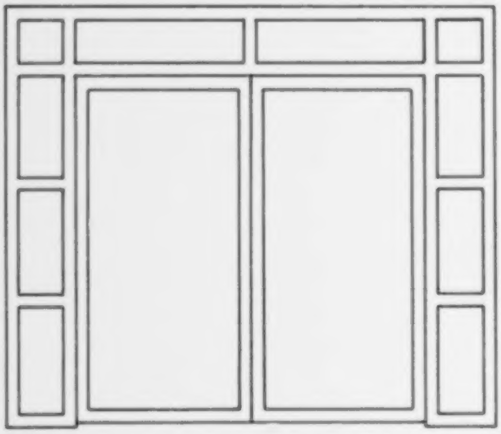
Types of Enties
(Aluminum Tubular Doors)


SINGLE


SINGLE WITH TRANSOM


DOUBLE WITH TRANSOM


DOUBLE TRANSOM ONE SIDE PANEL


DOUBLE TRANSOM TWO SIDE PANELS

EXTERIOR DOORS AND HARDWARE
UNIT IV

INFORMATION SHEET

I. Terms and definitions

A. Door frame — Assembly of parts that form an enclosure and support for a door

B. Head jamb — Top door frame member that contacts door

C. Side jamb — Side door frame member that contacts door

D. Threshold — Member formed or shaped with taper on each side; used to seal space between bottom of door and sill or floor

(NOTE: Thresholds are made of a variety of materials including wood, metal, and masonry products.)

E. Reveal — Space or setback of casing or trim from edge of door or window jamb; usually $^{1}/_{8}$ inch to $^{3}/_{16}$ inch

F. Clearance — Space between edge of door and jambs

G. Casing — Framework of trim around windows and doors

H. Miter — Joining of two pieces of material at an angle that is one-half the total angle of junction

EXAMPLE: Two pieces that meet to form a 90-degree angle will be cut to fit at 45 degrees.

I. Rail — Horizontal frame member in a door

J. Stile — Vertical frame member in a door

K. Butt — Type of door hinge in which one leaf is mortised into edge of door and other leaf is mortised into side jamb

L. Mortise — To cut a recess into a surface to allow fit of another surface

M. Jig — Device used for guiding tools or materials when performing a particular job

N. Astragal — Molding or trim attached to inside edge of one of a pair of doors to prevent door from swinging through; also used with sliding doors to ensure tighter fit where doors meet (See Figure 1)

INFORMATION SHEET

EXAMPLE:

FIGURE 1

O. Template — Gauge or pattern used as a guide to form or shape pieces being made

II. Basic classifications of exterior doors

A. Swinging

B. Sliding

C. Fixed

D. Overhead

E. Revolving

III. Types of entry doors (Figures 2-8)

A. Flush

(NOTE: The surface of a flush door is smooth. However, a flush door may have a glass inset or come with decorative molding attached to the door surface.)

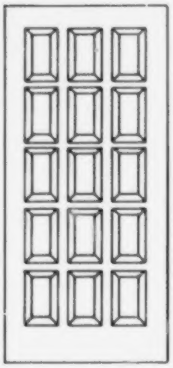
FIGURE 2

INFORMATION SHEET

B. Panel

(NOTE: Panel doors may have any number of panels. A single-panel door is generally referred to as a *plain panel door* while those with multiple panels are called *decorative panel doors*. The panels are generally square or rectangular, but also come in other shapes. Panels in metal doors are usually pressed into a single sheet of metal during manufacturing. The decorative moldings on flush doors are sometimes made to resemble panels.)

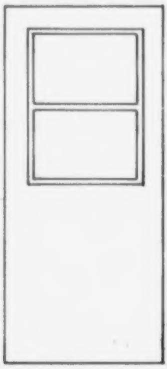
FIGURE 3



C. Sash

(NOTE: A sash door may have a fixed or movable window. The window may be divided into *lights*, such as the nine-light window shown on the combination door in Figure 5. Various types of glass are used, including insulated, reinforced, and leaded.)

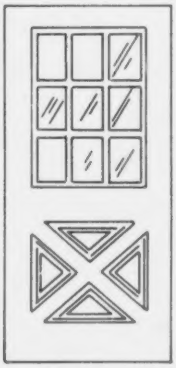
FIGURE 4



INFORMATION SHEET

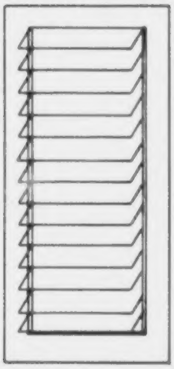
D. Combination

FIGURE 5



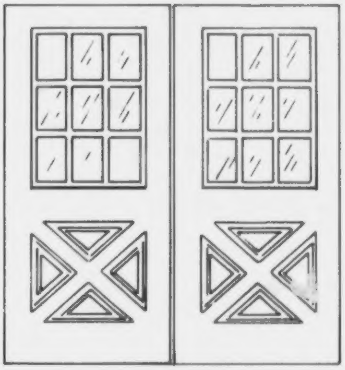
E. Jalousie

FIGURE 6



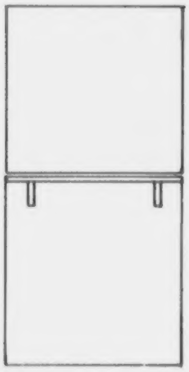
F. Double

FIGURE 7



G. Dutch

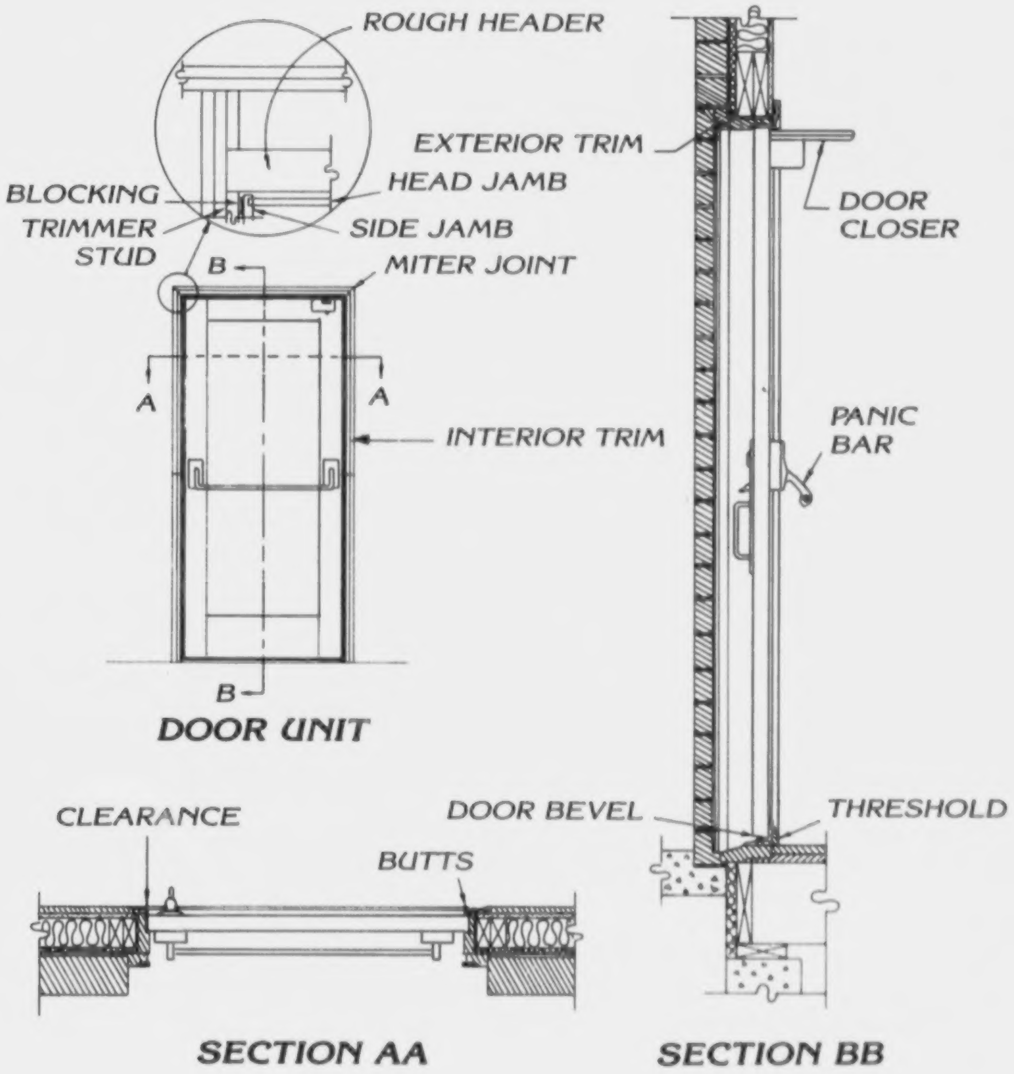
FIGURE 8



INFORMATION SHEET

IV. Parts of an exterior door installation (Figure 9)

FIGURE 9


ROUGH HEADER
EXTERIOR TRIM
HEAD JAMB
BLOCKING
TRIMMER STUD
SIDE JAMB
MITER JOINT
DOOR CLOSER
B
A
A
INTERIOR TRIM
PANIC BAR
B
DOOR UNIT
CLEARANCE
DOOR BEVEL
THRESHOLD
BUTTS
SECTION AA
SECTION BB

INFORMATION SHEET

V. Materials used in door construction

A. Face

(NOTE: The face of a door may be the exposed surface of solid lumber or a veneer applied over a core. Panel doors may consist of a frame of one material with panels of another material.)

1. Plywood

   (NOTE: Plywood used in door construction may be any of a number of woods.)

2. Fiberboard
3. Plastic laminate
4. Glass
5. Solid lumber
6. Metal

   (NOTE: Steel and aluminum are the most commonly used metals in door construction.)

B. Core

(NOTE: Doors have solid cores [SC], hollow cores [HC], or implanted cores. Solid cores consist of solid lumber or fill material such as wood blocks, particle board, or foam solidly packed between wood or metal faces. Hollow cores consist of frameworks of wood strips, metal honeycombs, or other designs that give the door rigidity. Implanted cores use blocks or columns of various materials to fill most of the core.)

1. Solid lumber
2. Wood blocks
3. Wood strips
4. Fiberboard
5. Volcanic minerals
6. Foam

INFORMATION SHEET

7. Polystyrene

8. Metal

9. Lead

   (NOTE: Lead core doors are used in hospitals and clinics to prevent the escape of radiation from X-ray equipment.)

VI. Materials used for exterior doorsills

A. Wood

B. Metal

C. Concrete

D. Stone

E. Brick

F. Marble

VII. Standard sizes of commercial doors

(NOTE: Door sizes are always given in this order: thickness, width, and height [$1\frac{3}{4}$" × 2'-8" × 6'-8"]. Normal thickness for an exterior door is $1\frac{3}{4}$ inches. The width of the jamb will be the width of the door plus the required clearance for each side. The jamb height will be the door height plus the height of the threshold plus the top clearance. For double doors, the jamb width is twice the door width, plus clearance, plus thickness of astragal.)

A. Width — 2'-0" to 4'-0"

B. Height — 6'-8" to 8'-0"

(NOTE: Doors may be ordered custom made to other sizes such as five-foot widths and ten-foot heights.)

VIII. Numbering system for doors

A. First two numbers indicate width in feet and inches

B. Second two numbers indicate height in feet and inches

EXAMPLE: 3/0×7/0 or 3070 or 30/70
Door is 3'-0" wide and 7'-0" high.

INFORMATION SHEET

IX. Recommended finish clearances and dimensions for hanging doors

(NOTE: When installing aluminum doors and frames allowance must be made for expansion.)

A. Clearance

1. At top and sides, door clearance should be $^3/_{32}$ inch

2. At bottom, door should be cut to minimum clearance to allow ease of operation

   (NOTE: Standard bottom clearance is $^5/_8$ inch. Where weatherstripping is used, more clearance may be necessary, depending on the type of weatherstripping. Also, when the door swings across carpet, the clearance may need to be increased at the bottom.)

B. Dimensions

1. Top hinge should be 7 inches from top of door

2. Bottom hinge should be 11 inches from bottom of door

3. Middle hinge should be centered between other two hinges

4. Door lockset should be centered 36 inches from floor

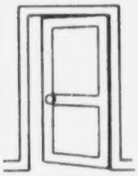
   (NOTE: These dimensions should be used unless otherwise specified. If there is a lock rail on the door, the lockset should be centered on this rail.)

X. Determining door swing (hand) (Figures 10-13)

(NOTE: The hand of an exterior door—the direction in which it opens and swings—is determined by facing the door from the outside of the building.)

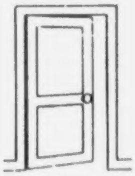
A. Right hand (RH)
(NOTE: Hinges are on right;
door swings in.)

FIGURE 10



B. Left hand (LH)
(NOTE: Hinges are on left;
door swings in.)

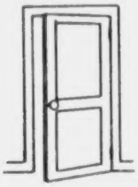
FIGURE 11



INFORMATION SHEET

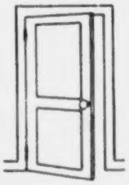
C. Right-hand reverse (RHR)
(NOTE: Hinges are on right; door swings out.)

FIGURE 12



D. Left-hand reverse (LHR)
(NOTE: Hinges are on left; door swings out.)

FIGURE 13



XI. Exterior door and miscellaneous hardware (Figures 14 - 35)

(NOTE: A wide variety of hardware is used with exterior doors. Additionally, commerical construction requires the use of various other hardware devices not necessarily used with doors. The following list shows examples of the most common of each type of hardware.)

A. Standard door locks

FIGURE 14: Unit lock

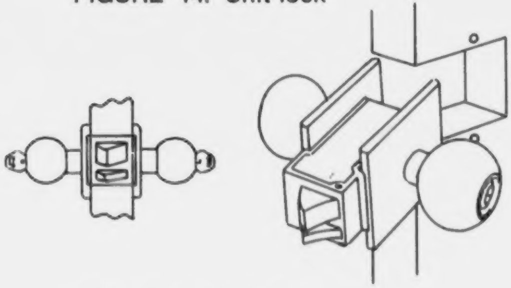


FIGURE 15: Cylindrical lock

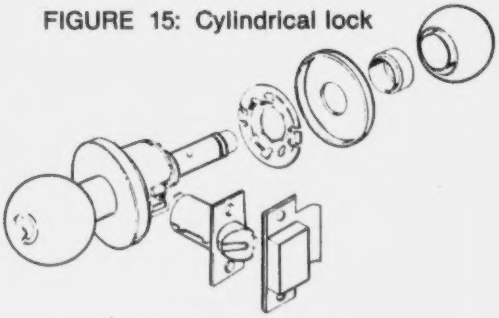


FIGURE 16: Mortise lock

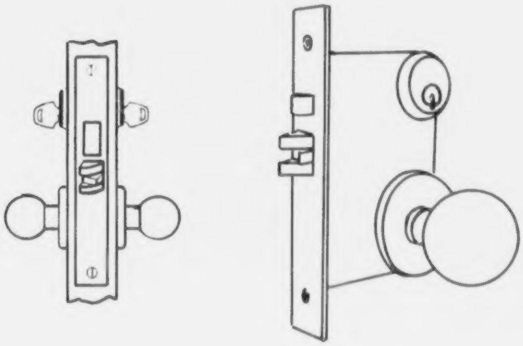
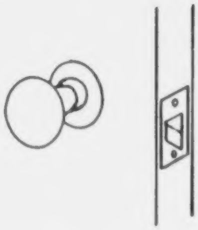


FIGURE 17: Tubular lock



INFORMATION SHEET

B. Security locks

FIGURE 18: Bolt lock

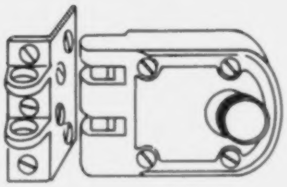


FIGURE 19: Deadbolt

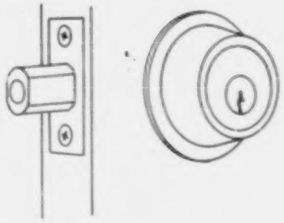


FIGURE 20: Electrified cylindrical lock

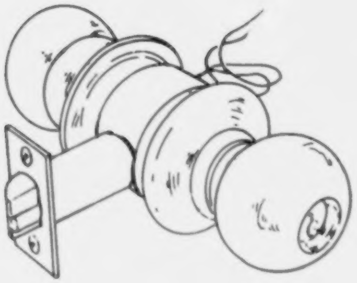
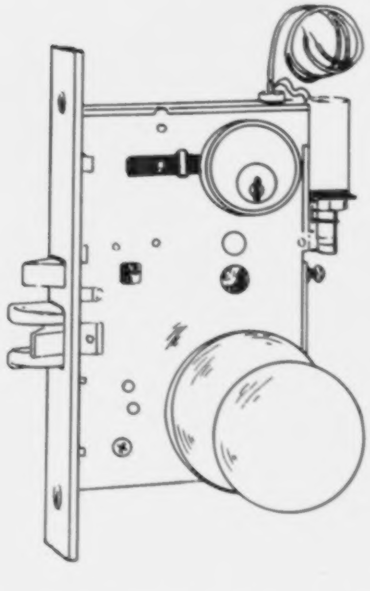


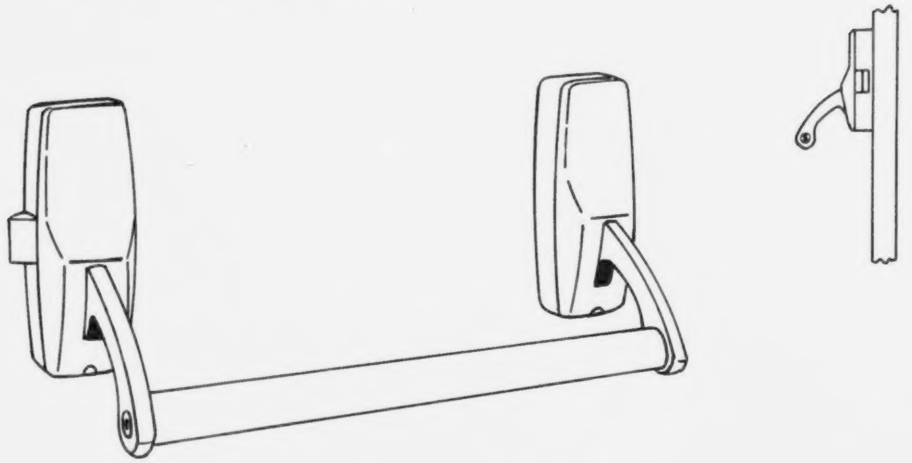
FIGURE 21: Electrified mortise lock



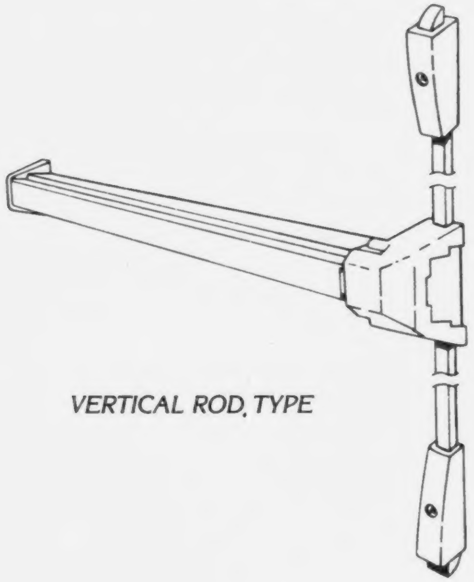
(NOTE: The electrified locks may be controlled by wall switches, timer devices, coded cards, computers, telephone connections, push buttons, combination devices, or master control panels.)

INFORMATION SHEET

FIGURE 22: Panic exit devices



HORIZONTAL TYPE

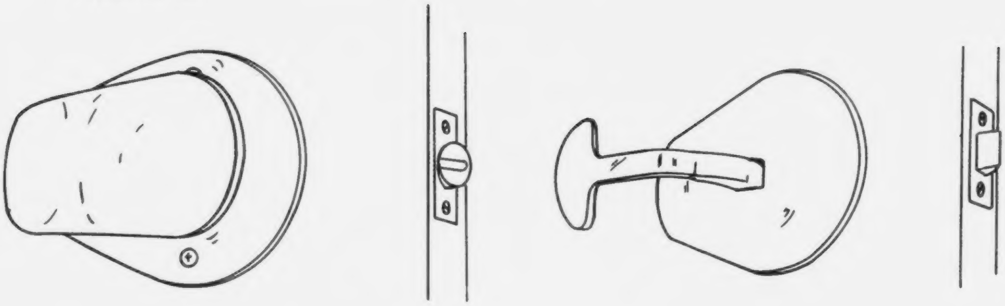


VERTICAL ROD, TYPE

(NOTE: Locking device for panic exit may be vertical rod or rim type.)

C. Push-pull latch set

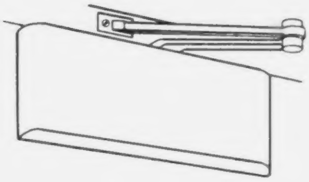
FIGURE 23



D. Door closers

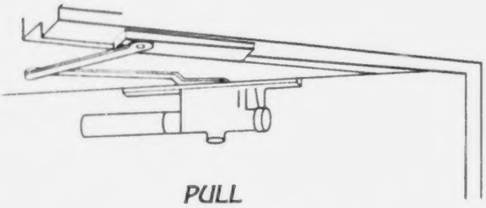
1. Surface-mounted types

FIGURE 24



PUSH

FIGURE 25



PULL

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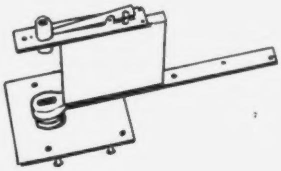
2. Concealed floor closer

FIGURE 26

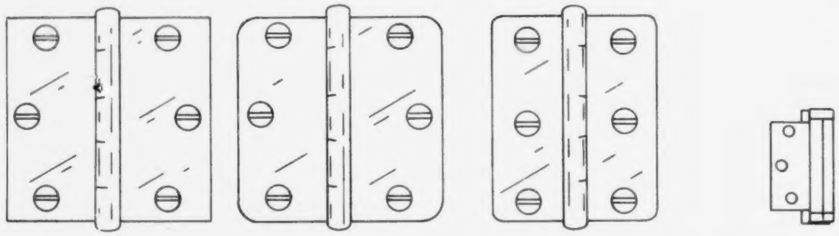


(NOTE: There are several special types of door closers such as delayed action, low rate spring power, automatic closing and others. These special types were designed for the handicapped and for fire protection.)

INFORMATION SHEET

E. Standard door butts

FIGURE 27



FULL MORTISE WITH SQUARE CORNERS

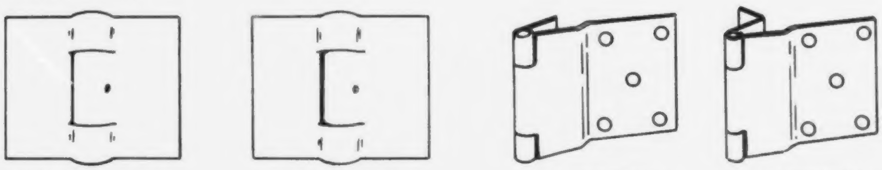
FULL MORTISE WITH ROUND CORNERS

HALF MORTISE

SPRING HINGE

F. Special hinges

FIGURE 28

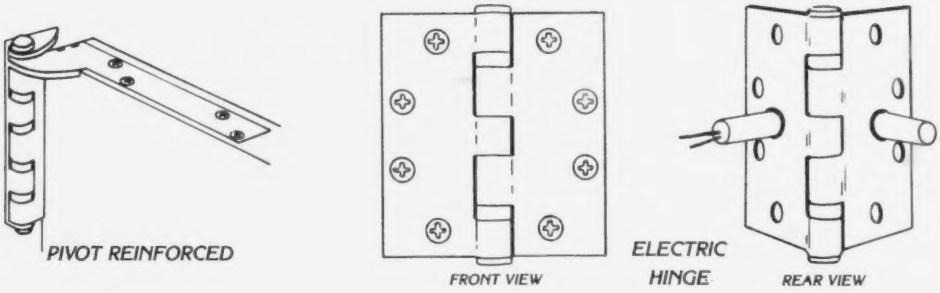


DOUBLE WEIGHT

TRIPLE WEIGHT

FULL SURFACE

HALF SURFACE

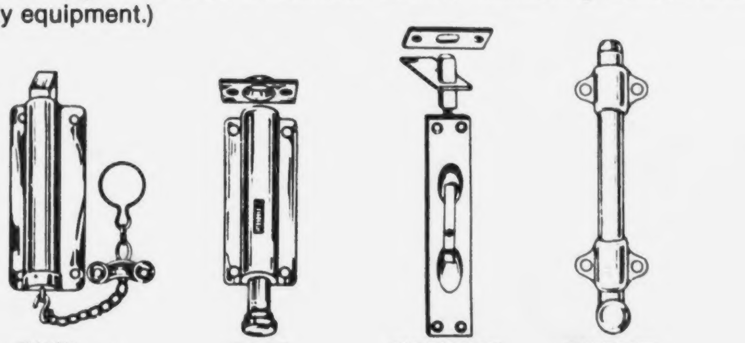


PIVOT REINFORCED
FRONT VIEW
ELECTRIC HINGE
REAR VIEW

(NOTE: Electric hinges are used to activate alarms, monitoring devices and other security equipment.)

G. Bolt locks

FIGURE 29



CHAIN

FOOT

EXTENSION

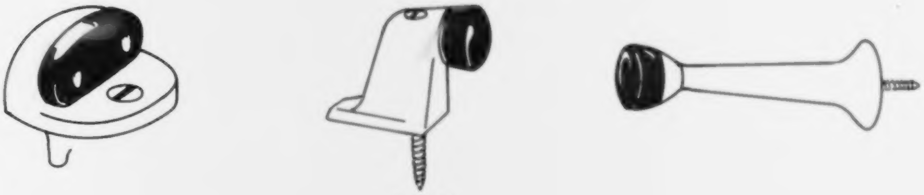
SURFACE

INFORMATION SHEET

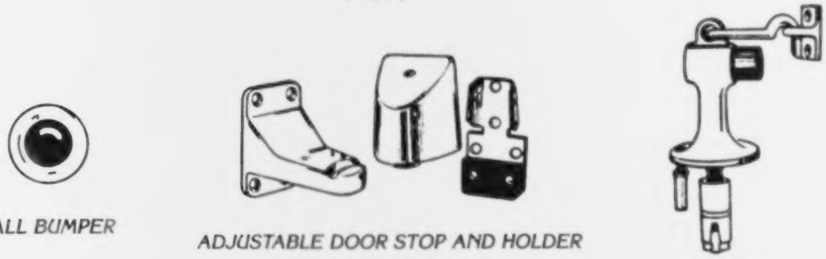
H. Door stops, bumpers, and holders

(NOTE: The term doorstop also applies to the strip of molding on a doorjamb against which the door closes.)

FIGURE 30



STOPS



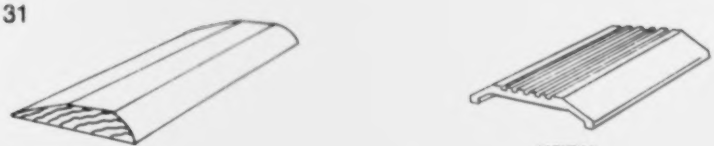
WALL BUMPER

ADJUSTABLE DOOR STOP AND HOLDER

HOLDER

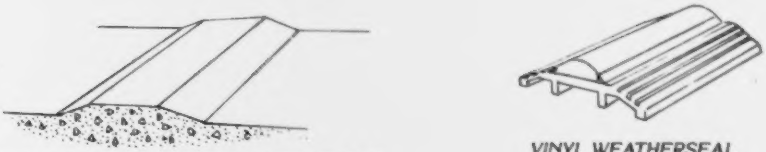
I. Thresholds

FIGURE 31



WOOD

METAL

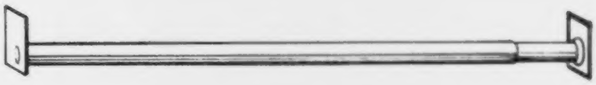


CONCRETE POURED MONOLITHIC WITH FLOOR

VINYL WEATHERSEAL

J. Closet rod

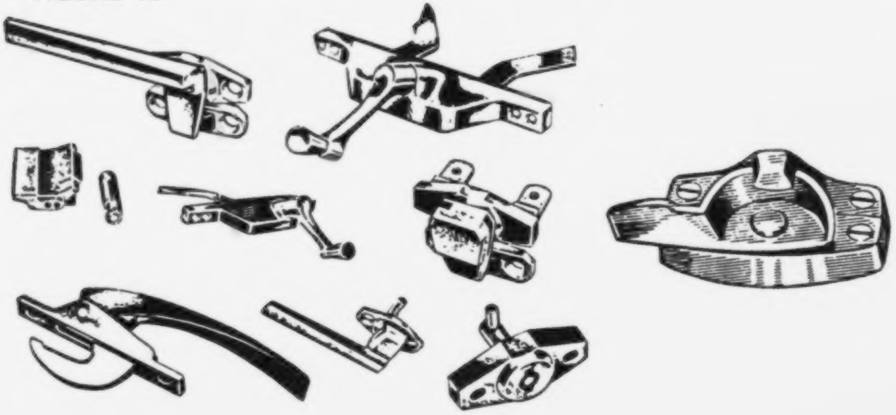
FIGURE 32



INFORMATION SHEET

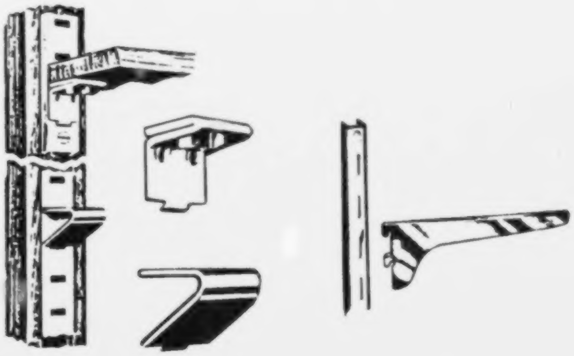
K. Window hardware

FIGURE 33



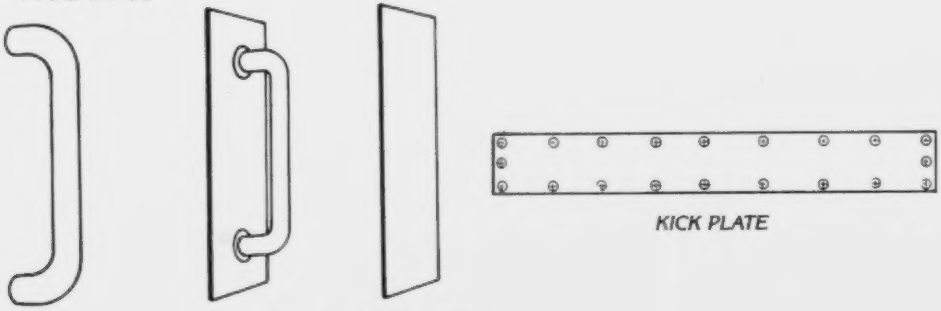
L. Shelf supports and brackets

FIGURE 34



M. Door pulls, pull plates, push plates, and kick plates

FIGURE 35



PULL

PULL PLATE

PUSH PLATE

KICK PLATE

EXTERIOR DOORS AND HARDWARE
UNIT IV

JOB SHEET #1 — INSTALL A METAL THRESHOLD ON A CONCRETE FLOOR

I. Tools and materials

- A. Folding rule or steel tape
- B. Hammer
- C. Screwdriver
- D. Hacksaw
- E. Drill motor, masonry drills, and extension cord
- F. Eye protection
- G. Metal threshold and manufacturer's installation instructions
- H. Concrete screw anchors
- I. Screws
- J. Caulking gun and caulk

II. Procedure

- A. Read manufacturer's installation instructions
- B. Measure door opening between side jambs; transfer measurement to threshold
- C. Use hacksaw to cut threshold to length
- D. Cut opening for doorstops
    1. Measure thickness of doorstop
    2. Mark thickness of doorstop from each end of threshold along outside edge of threshold
    3. Cut along line at mark deep enough to allow for doorstop when closed door is centered over weatherseal

       (NOTE: The threshold should be positioned so that the closed door is approximately centered over the weatherseal. See Figures 37 and 38.)

JOB SHEET #1

FIGURE 37

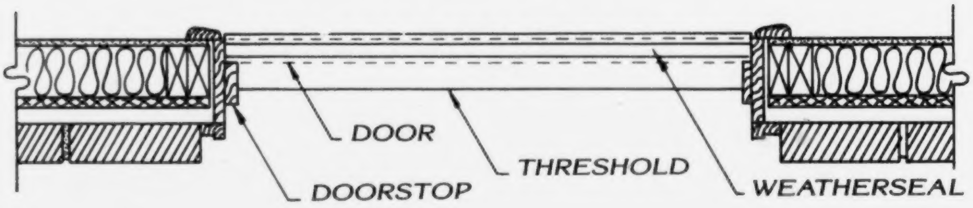
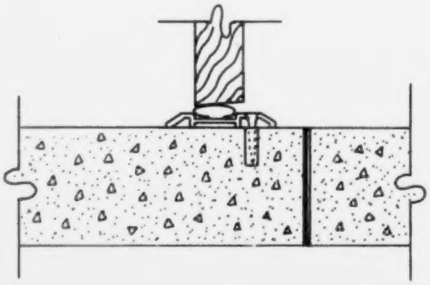


FIGURE 38



4. Cut in from each end to provide notch for doorstops

E. Place threshold in position to check for proper fit

F. With threshold in proper position, mark along each edge of threshold and through screw holes onto concrete floor

G. Remove threshold

H. Put on eye protection

I. Drill holes into concrete at each screw location, using proper drill for the anchors being used

J. Clean out each hole

K. Insert anchor in each hole and tap in place

L. Run a small bead of caulk along inside of each of the two marked lines on floor, approximately where edges of threshold will rest, and run bead of caulking material along ends of threshold

M. Press threshold into place

JOB SHEET #1

N. Start all screws, and then tighten evenly

O. Clean up caulk that may have squeezed from under threshold

P. Clean work area and return tools and materials to proper storage

EXTERIOR DOORS AND HARDWARE
UNIT IV

JOB SHEET #2 — INSTALL AN EXTERIOR PREHUNG DOOR UNIT

I. Tools and materials

  A. Folding rule or steel tape

  B. 30-inch and 4-foot or 6-foot hand levels

  C. Framing and try square

  D. Claw hammer

  E. Handsaw

  F. Nail sets

  G. Caulking gun and sealer

  H. Prehung door unit and manufacturer's insutructions

  I. Wood shingles for blocking shims

  J. 16d and 8d casing nails; 4d and 6d finish nails

  K. Fiberglass insulation or sill sealer

  L. Eye protection

II. Procedure

  A. Remove crate from door unit

  B. Check unit for damage

  C. Check rough opening

    1. Check for proper dimensions

    2. Check that side jambs are plumb

    3. Check that header is level and square

    4. Check that floor is level at installation site

  D. Center unit temporarily in opening

  E. Check to see that threshold is level and that outside trim is tight against wall

  (NOTE: Use shims to level threshold if required.)

JOB SHEET #2

F. With unit in proper position, mark along inside edge of threshold

G. Remove unit from opening

H. Run a bead of caulk on floor inside marked line, approximately where edges of threshold will rest; and run a bead at jamb end locations

I. Set door unit back in center of rough opening

J. Open the door and recheck threshold for level

K. Check that header is level

L. Put on eye protection

M. Temporarily nail side jambs in place, taking care not to drive nails all the way in

N. Plumb hinge jamb by inserting shims at top of hinge jamb and just above threshold

O. Nail jamb in position through shims and into trimmer studs

P. Adjust for proper clearance by inserting shims at each hinge

Q. Nail jamb through hinge shims

(NOTE: Some carpenters like to remove one screw from each hinge and replace it with a long screw that will help anchor the jamb to the rough frame.)

R. Insert shims on lock jamb, starting at top, then moving to bottom, and then to center at strike location

S. Nail jamb to rough framing through each set of shims

(NOTE: It may be necessary to add two more sets of shims between the top and center and center and bottom in order to adjust to proper clearance.)

T. Close door and recheck for proper clearance

U. Cut off shims that may protrude outside of frame

V. Nail exterior trim, using 8d casing nails spaced about 16 inches apart

W. Fill opening between jamb and trimmer studs with fiberglass insulation or sill sealer

X. Install interior trim and lockset

Y. Adjust threshold if necessary

(NOTE: Follow manufacturer's instructions to adjust the threshold.)

Z. Clean work area and return tools and materials to proper storage

EXTERIOR DOORS AND HARDWARE
UNIT IV

JOB SHEET #3 — INSTALL ENTRY DOOR FRAME, CASING, DOOR, AND LOCK

I. Tools and materials

- A. Folding rule or steel tape
- B. 30-inch or 78-inch hand level or jamb level
- C. Framing and try square
- D. Claw hammer
- E. Power handsaw
- F. Power planer
- G. Router and door hanging kit
- H. Drill motor and drills
- I. Nail sets
- J. Flat-blade and Phillips screwdrivers
- K. Handsaw
- L. Self-centering punch
- M. Power miter saw or bucksaw and extension cord
- N. Door jack
- O. One pair sawhorses
- P. Door frames ($1\frac{1}{4}$" × $4\frac{5}{8}$")
- Q. Door (3′ –0″ × 7′ –0″)
- R. 1x6 for door spreader
- S. Door casing
- T. Butt hinges
- U. Cylindrical lockset with template and manufacturer's instructions

JOB SHEET #3

- V. Wood shingles for blocking shims
- W. Nails
- X. Wood chisels
- Y. Eye protection

II. Procedure

- A. Check rough opening
  1. Check for proper dimensions

     (NOTE: The rough opening should be the same width as the door width plus door and jamb clearance, plus jamb thickess, plus jamb and trimmer clearance. The rough opening height should be the height of the door plus threshold thickness, top clearance, jamb thickness, and jamb and header clearance. The actual size for a 3′-0″ × 7′-0″ door is 3′-2½″ × 7′-2″.)
  2. Check that side jambs are plumb
  3. Check that header is level and square
- B. Assemble door frame, nailing side jambs to header jamb with 10d casing nails
- C. Install door frame
  1. Place frame in opening
  2. Center frame in opening, with side jambs resting on floor and inside flush with face of wall
  3. Place spreader on floor between side jambs

     (NOTE: The door spreader will be the same length as the header between the two side jambs.)
  4. Wedge frame in opening, using shims at top and bottom on both sides of frame
  5. Level header jamb and then temporarily secure frame to trimmer studs on both sides
  6. Determine swing (hand) of door and mark hinge side on frame
  7. Plumb hinge side of jamb by temporarily nailing shims behind hinge locations

     (NOTE: Hinges are located 7 inches down from top of door, 11 inches from bottom of door, and centered between the other two locations.)

JOB SHEET #3

8. Use straightedge or jamb level on hinge side to check frame while placing intermediate shims behind side jamb where needed
9. Recheck that hinge side of jamb is straight, plumb, and square
10. Put on eye protection
11. Use 10d casing nails to secure jamb, and then finish driving all nails into jamb

    (NOTE: Be sure that inside edges of jamb are flush with interior wall and that frame is centered in the opening.)
12. Follow same procedures to secure other side jamb

    (NOTE: Be sure to install blocking at latch location if required.)
13. Check that jambs are level, plumb, square, straight, and properly spaced

D. Install door casing

(NOTE: This procedure calls for installing the header casing first, but some carpenters prefer to install the side jambs first.)

1. Select casing
2. Establish and mark reveal near top and bottom of side jambs
3. Determine and mark length of head casing
4. Use power miter saw or bucksaw to make miter cut on both ends of head casing
5. Temporarily nail head casing in place
6. Cut miter on upper end of each side casing
7. Hold side casing in place—with miter down—and mark position for square cut on bottom of casing

   (NOTE: The position of the bottom square cut should be even with the top of the head casing.)
8. Nail side casings in place

   (NOTE: Some carpenters use glue at miters or finish the joints in some other way.)
9. Drive all nails to complete nailing pattern

   (NOTE: Use 4d or 6d finish nails along inside edge, spaced about 16 inches apart; use 8d finish nails along outside edge about 16 inches apart.)

JOB SHEET #3

10. Use nail set to set all exposed nailheads in casing

E. Install door

1. Check door fit in finished opening; if necessary, trim door to fit the opening

   (NOTE: Maintain a clearance of $^3/_{32}$ inch on top and both sides of door and about $^5/_8$ inch at bottom of door. Adjust bottom clearance to allow for finish flooring.)

   a. Lock door in door jack

   b. Use power planer to trim door

   > **CAUTION**
   >
   > Make very thin cuts with power planer to avoid trimming off too much of door.

   c. Recheck door fit, repeating procedure if necessary until proper fit is obtained

2. Bevel edge of door on lock side to approximately 3 to 5 degrees

3. Lock door in door jack and position router template on hinge edge of door, with hinge template set at hinge locations

4. Set router for proper depth of cut

5. Use router to cut gains for butt hinges

6. Remove template from door

7. Install hinges on door, with tops of hinge pins toward top of door

8. Attach router template to doorjamb, positioning it to make matching cuts on jamb

9. Use router to cut gains on doorjamb

10. Remove template from doorjamb

11. Install on doorjamb free leaves of hinges

12. Remove door from door jack and hang door in place

13. Check clearance between door and doorjambs

JOB SHEET #3

F. Install door lock

(NOTE: Follow instructions and details furnished with each lock.)

1. Open door and wedge it so that it will not move
2. Measure 36 inches up from floor and mark edge of door
3. Use try square to continue this mark about 3 inches in from edge of door
4. Fold lockset template on pre-scribed line; place template on edge of door so that center lines of openings are centered on 36-inch height line
5. Mark center of the $^{7}/_{8}$-inch hole on door edge and $2^{1}/_{8}$-inch hole on face of door

   (NOTE: If boring jig is available, the template is not necessary because the jig can be adjusted for the different holes and different door thicknesses.)

6. Bore $2^{1}/_{2}$-inch hole through face of door and $^{7}/_{8}$-inch hole into edge of door
7. Use appropriate chisel to mortise for latch plate
8. Install latch unit
9. Locate, mortise, and install striker plate
10. Adjust lock for thickness of door
11. Install lock in hole, making sure that lock case hooks the retaining legs and retractor hooks the bolt tails
12. Install rose plate; insert screws and tighten
13. Install rose plate on opposite side; snap rose over retaining spring until it is tight against door
14. Align inside knob with slot on side of spindle and push knob in until it locks in place
15. Remove wedges from door
16. Close door and check to see if lock is properly installed

G. Clean work area and return tools and materials to proper storage

EXTERIOR DOORS AND HARDWARE
UNIT IV

JOB SHEET #4 — INSTALL BRONZE WEATHERSTRIPPING

I. Tools and materials

- A. Folding rule or steel tape
- B. Tin snips
- C. Utility knife
- D. Screwdriver
- E. ¼-inch drill motor, drill, and extension cord
- F. Weatherstripping
- G. Screws for attaching weatherstripping
- H. Pencil
- I. Eye protection

II. Procedure

- A. Cut weatherstripping to length
    1. Measure between the two side jambs on the part of header jamb that is not rabbeted or does not include doorstop
    2. Transfer measurement to weatherstripping
    3. Cut metal part of weatherstripping with tin snips; use utility knife to cut other material on a miter at both ends
    4. Measure from floor to header on part of side jambs that is not rabbeted or does not include doorstop
    5. Transfer measurements to the weatherstripping
    6. Cut weatherstripping as described above, with miter at top
- B. Install weatherstripping

    (NOTE: Weatherstripping should be attached to the center section of the frame, flush with the rabbeted edge or with the doorstop.)

    1. Position header jamb weatherstripping on jamb, with seal material flush with rabbeted edge or doorstop

JOB SHEET #4

2. Mark on doorjamb the location of screw slots or nail holes in weatherstripping
3. Put on eye protection
4. If screws are used for installation, remove weatherstripping and drill appropriate-sized hole in center of marked slots
5. Position weatherstripping back on header, and install screws or nails

   (NOTE: If weatherstripping has slots for adjustment, do not tighten the screws. Leave the weatherstripping so that, when ready, it can be slipped into proper position.)
6. Use same procedures to install weatherstripping on side jambs
7. Close door
8. For adjustable mountings
   a. Slide weatherstripping snug against door at header and tighten all screws
   b. Slide weatherstripping snug against door at side jambs and tighten all screws
9. Open door and check weatherstripping for proper position

   (NOTE: Weatherstripping should protrude over the edge approximately 1/8 inch. For proper fit, the seal should compress against the closed door.)

C. Clean work area and return tools and materials to proper storage

EXTERIOR DOORS AND HARDWARE
UNIT IV

JOB SHEET #5 — INSTALL DOOR FRAME AND INSIDE JAMBS FOR AN OVERHEAD DOOR

I. Tools and materials

- A. Folding rule and steel tape
- B. 4-foot or 6-foot hand level
- C. Framing and try square
- D. Claw hammer
- E. Power handsaw and extension cord
- F. Caulking gun and caulk
- G. One pair sawhorses
- H. 6-foot stepladder
- I. Door and manufacturer's specifications and details
- J. 2×7s for door frames and 2×6s for inside jambs
- K. Wood shingles for blocking shims
- L. 12d or 16d galvanized casing nails

II. Procedure

- A. Check rough opening
    - 1. Check for proper dimensions
    - 2. Check that side jambs are plumb
    - 3. Check that header is level and square

      (NOTE: The rough opening should be the same as the door size, plus thickness of frame, plus clearance.)
- B. Cut door frame members to size

  (NOTE: The header jamb should be the width of the door plus twice the thickness of the side jamb. The side jambs should be the same as the height of the door.)

JOB SHEET #5

C. Install finish header jamb

  1. Determine height of finish header
  2. Install header at desired height, flush with interior wall
  3. Use shingles to shim header level
  4. Nail header in place and check for level

D. Install finish side jambs

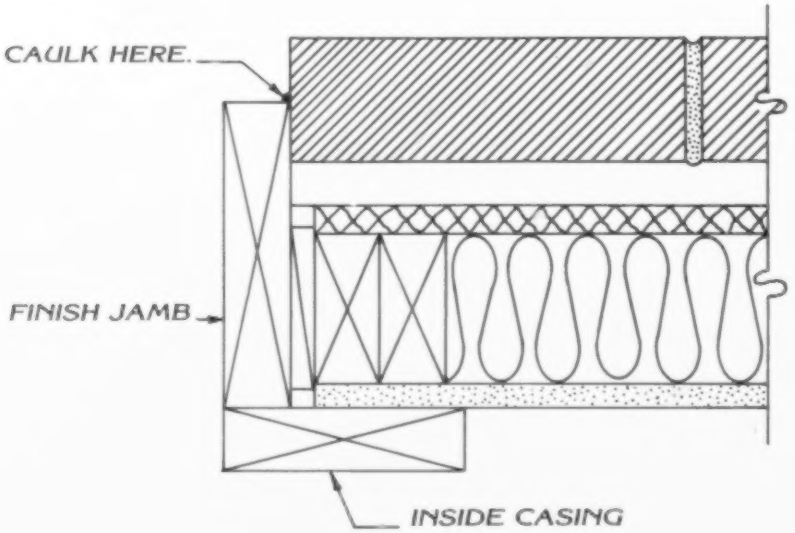
  1. Install first side jamb flush with interior wall
  2. Use shingles to shim jamb plumb and square
  3. Nail jamb in place and check for plumb and square
  4. Install second side jamb in same manner
  5. Check finish opening to see that it is size of garage door

E. Cut and install inside casing and track-mounting supports

(NOTE: The inside side casing is installed full length between the floor and ceiling.)

  1. Measure distance between floor and ceiling and cut side casing to this length
  2. Install side casing flush with the face of finish frame (Figure 39)

FIGURE 39



JOB SHEET #5

    3. Cut and install inside header casing between two side casings and flush with face of finish header

    4. Cut and install center vertical mounting support between inside header casing and ceiling

F. Caulk outside of finish door frame between frame and brick if used

(NOTE: Doorstops will be furnished and installed by the door hanger.)

G. Check work for level, plumb, and square

H. Clean work area and return tools and materials to proper storage

EXTERIOR DOORS AND HARDWARE
UNIT IV

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with exterior doors to their correct definitions. Write the correct numbers in the blanks. Definitions continue on the next page.

______a. Space between edge of door and jambs

______b. Gauge or pattern used as a guide to form or shape pieces being made

______c. Type of door hinge in which one leaf is mortised into edge of door and other leaf is mortised into side jamb

______d. Top door frame member that contacts door

______e. Vertical frame member in a door

______f. Molding or trim attached to inside edge of one of a pair of doors to prevent door from swinging through; also used with sliding doors to ensure tighter fit where doors meet

______g. Space or setback of casing or trim from edge of door or window jamb; usually 1/8 inch to 3/16 inch

______h. Assembly of parts that form an enclosure and support for a door

______i. To cut a recess into a surface to allow fit of another surface

______j. Joining of two pieces of material at an angle that is one-half the total angle of junction

______k. Side door frame member that contacts door

______l. Framework of trim around windows and doors

______m. Member formed or shaped with taper on each side; used to seal space between bottom of door and sill or floor

1. Casing
2. Door frame
3. Side jamb
4. Template
5. Reveal
6. Threshold
7. Head jamb
8. Jig
9. Miter
10. Clearance
11. Astragal
12. Butt
13. Rail
14. Mortise
15. Stile

TEST

______n. Horizontal frame member in a door

______o. Device used for guiding tools or materials when performing a particular job

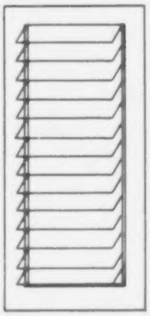
2. State two basic classifications of exterior doors.

a. ____

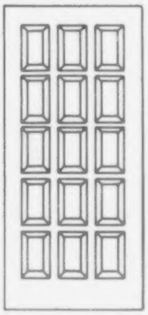
b. ____

3. Identify the following types of entry doors. Write the correct names in the blanks.

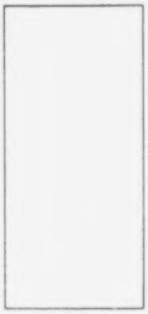
Double **Combination** **Panel** **Dutch** **Flush** **Jalousie** **Sash**



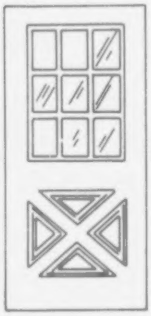
a.______________



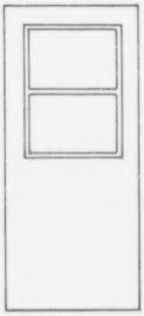
b.______________



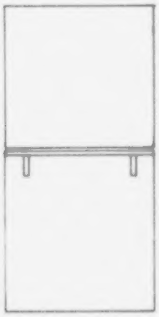
c.______________



d.______________



e.______________



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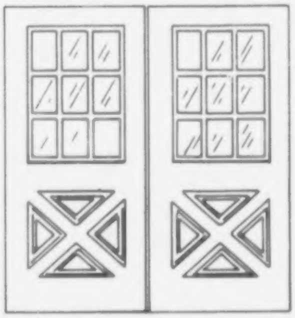
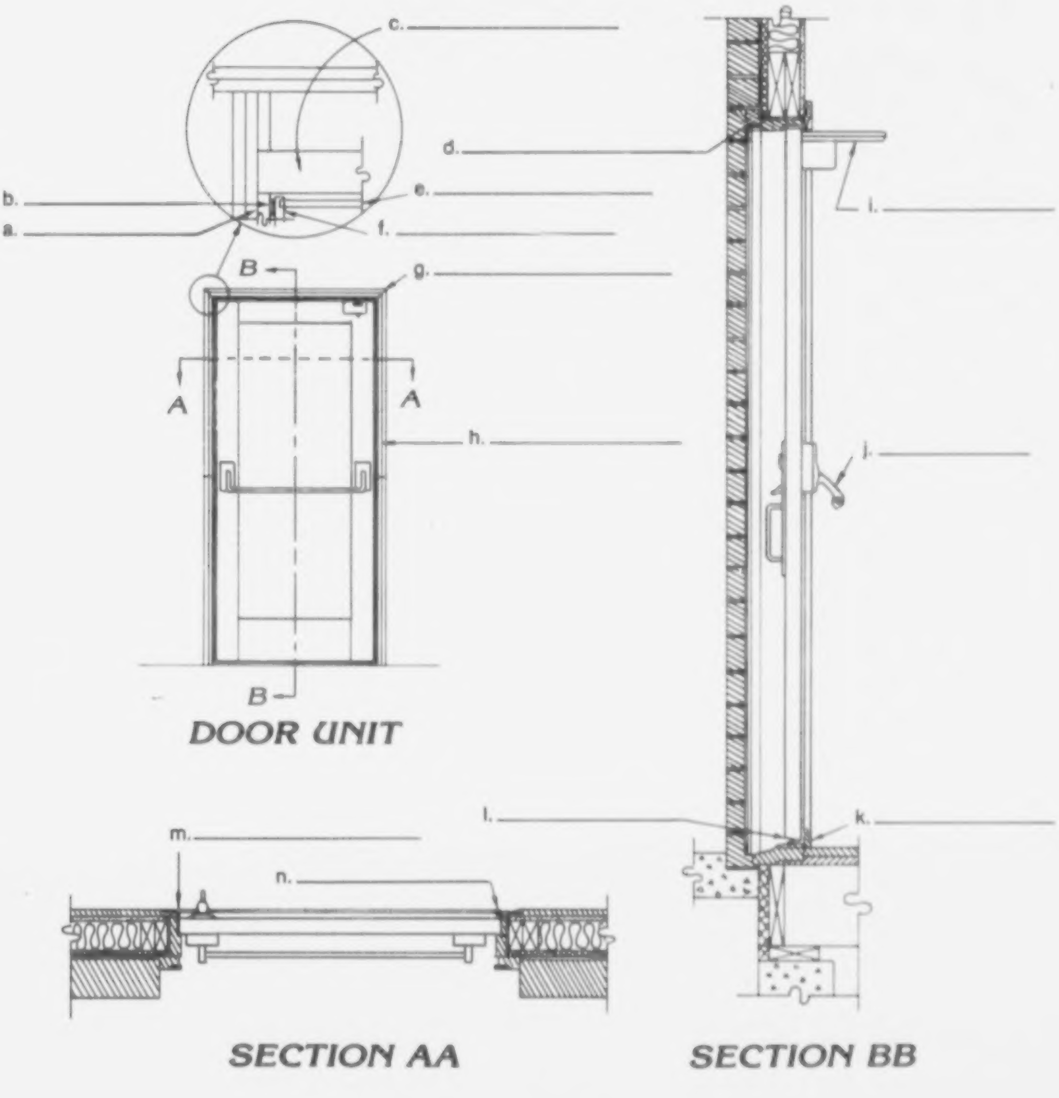


g.______________

TEST

4. Identify the parts of the exterior door installation illustrated below. Write the correct names in the blanks.

Door bevel
Trimmer stud
Panic bar
Side jamb
Blocking
Interior trim
Head jamb
Exterior trim
Miter joint
Clearance
Rough header
Door closer
Butts
Threshold



DOOR UNIT

SECTION AA

SECTION BB

TEST

5. List materials used in door construction.

Face (List three.)

a. ____________________

b. ____________________

c. ____________________

Core (List three.)

a. ____________________

b. ____________________

c. ____________________

6. Name three materials used for exterior doorsills.

a. ____________________

b. ____________________

c. ____________________

7. Select from the following list standard sizes of commercial doors. Write an "X" in the blank before each correct size.

_____a. 2'-6" × 6'-8"

_____b. 2'-6" × 7'-3"

_____c. 2'-8" × 8'-4"

_____d. 2'-8" × 6'-8"

_____e. 2'-11" × 7'-4"

_____f. 2'-8" × 8'-1"

_____ g. 3'-0" × 6'-8"

_____ h. 3'-0" × 6'-11"

_____ i. 3'-0" × 7'-0"

_____ j. 4'-0" × 7'-0"

_____ k. 4'-0" × 8'-0"

_____ l. 5'-0" × 10'-0"

8. Explain the numbering system for doors.

a. ____________________

b. ____________________

TEST

9. Complete statements about the recommended clearances and dimensions for hanging doors. Write the correct answers in the blanks provided.

Clearance

a. At ____________ and ____________, door clearance should be 3/32 inch

b. At ____________, door should be cut to minimum clearance to allow ease of operation

Dimensions

a. Top hinge should be ____________ inches from top of door

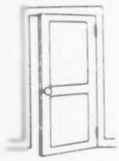
b. Bottom hinge should be ____________ inches from bottom of door

c. Middle hinge should be centered between ____________ ____________ ____________

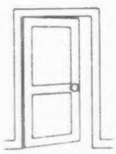
d. Door lockset should be centered ____________ inches from floor

10. Identify door swing (hand) of the doors illustrated below. Write the correct names in the blanks.

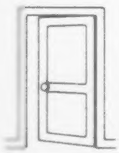
Right hand (RH) **Left hand (LH)** **Left-hand reverse (LHR)** **Right-hand reverse (RHR)**



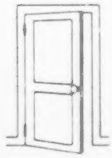
a. ________________________________



b. ________________________________



c. ________________________________

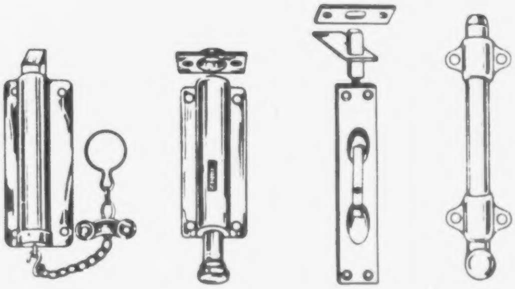


d. ________________________________

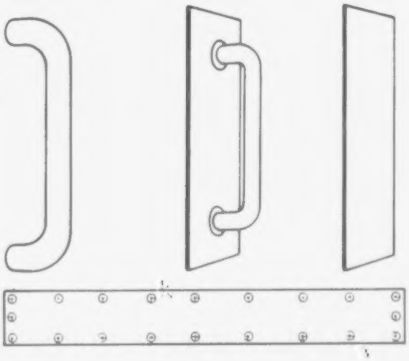
TEST

11. Identify the following illustrations of exterior door hardware. Write the correct names in the blanks. Some answers will be used more than once.

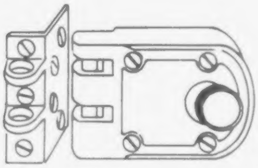
Unit lock
Cylindrical lock
Mortise lock
Tubular lock
Security boltlock
Deadbolt security lock
Electrified cylindrical lock
Electrified mortise lock
Panic exit device
Push-pull latch set
Window hardware
Shelf supports and brackets
Closet rod
Surface-mounted door closer
Concealed floor closer
Standard door butt
Special hinges
Bolt locks
Door stops, bumpers, and holders
Threshold
Door pulls, pull plates, push plates, and kick plates



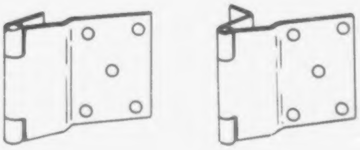
a. ______________________________



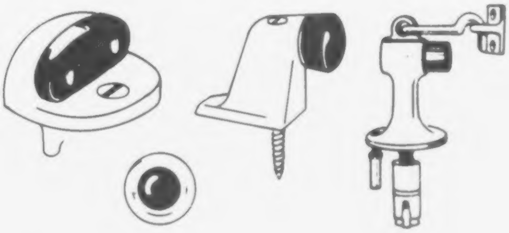
b. ______________________________



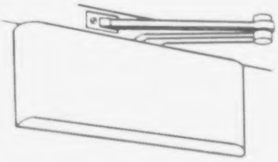
c. ______________________________



d. ______________________________

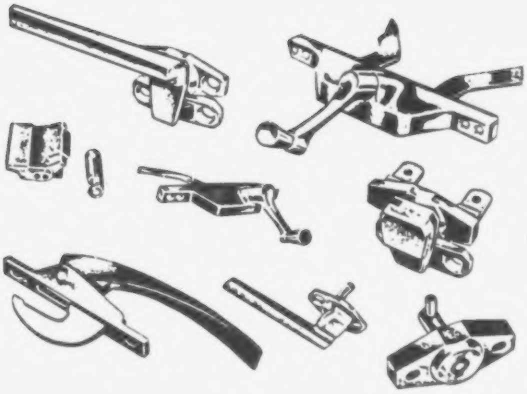


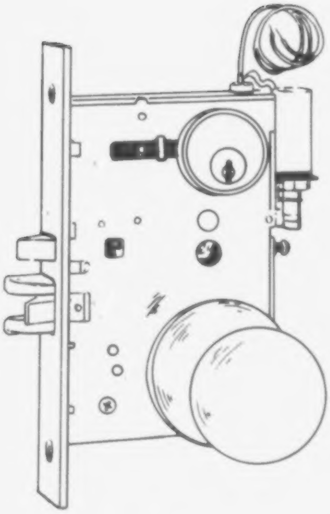
e. ______________________________



f. ______________________________

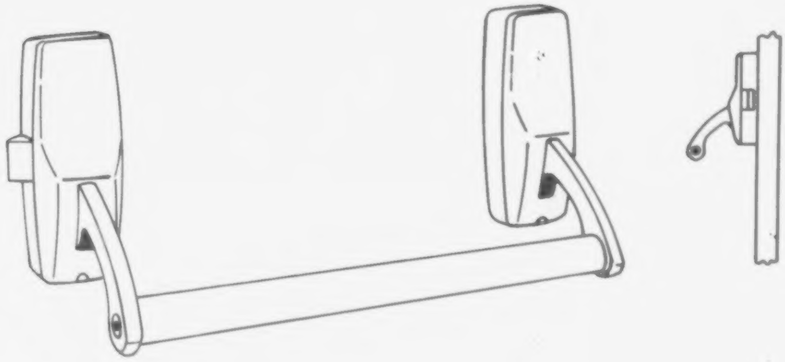
TEST



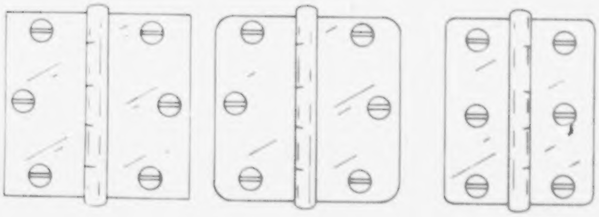


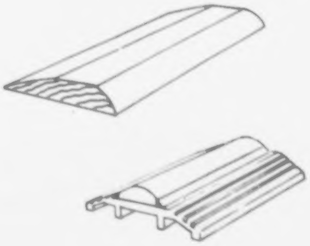
g. ______________________________

h. ______________________________



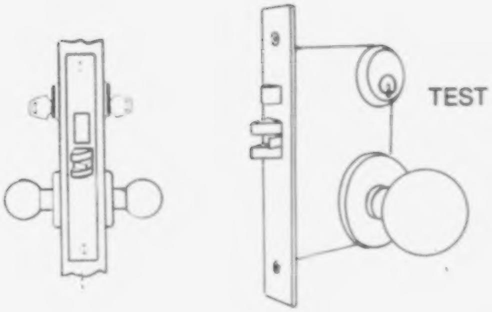
i. ______________________________

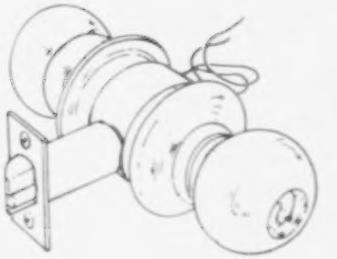




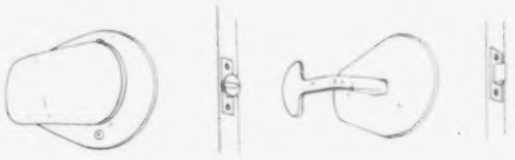
j. ______________________________

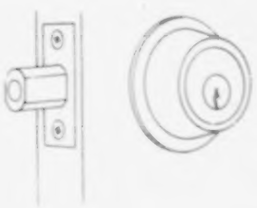
k. ______________________________



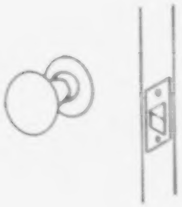


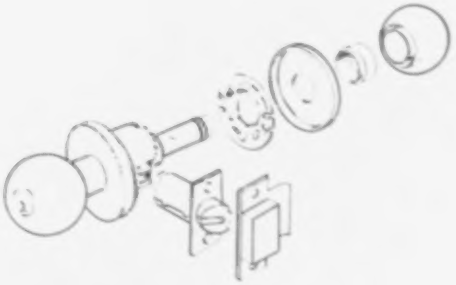
l. ______________________________ m. ______________________________



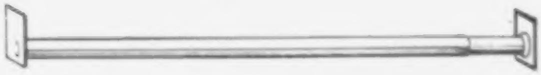


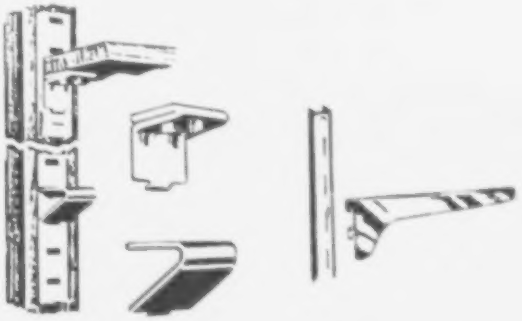
n. ______________________________ o. ______________________________





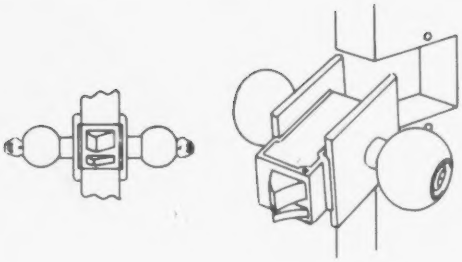
p. ______________________________ q. ______________________________



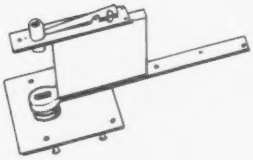


r. ______________________________ s. ______________________________

TEST



t. ________________________



u. ________________________

(NOTE: Test question 12 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

13. Demonstrate the ability to

    a. Install a metal threshold on a concrete floor.

    b. Install an exterior prehung door unit.

    c. Install entry door frame, casing, door, and lock.

    d. Install weatherstripping.

    e. Install door frame and inside jambs for an overhead door.

EXTERIOR DOORS AND HARDWARE
UNIT IV

ANSWERS TO TEST

1.
   a. 10
   b. 4
   c. 12
   d. 7
   e. 15
   f. 11
   g. 5
   h. 2
   i. 14
   j. 9
   k. 3
   l. 1
   m. 6
   n. 13
   o. 8

2. Answer should include any two of the following

   a. Swinging
   b. Sliding
   c. Fixed
   d. Overhead
   e. Revolving

3.
   a. Jalousie
   b. Panel
   c. Flush
   d. Combination
   e. Sash
   f. Dutch
   g. Double

4.
   a. Trimmer stud
   b. Blocking
   c. Rough header
   d. Exterior trim
   e. Head jamb
   f. Side jamb
   g. Miter joint
   h. Interior trim
   i. Door closer
   j. Panic bar
   k. Threshold
   l. Door bevel
   m. Clearance
   n. Butts

5. Answer should include any three of the following in each group

   Face
   a. Plywood
   b. Fiberboard
   c. Plastic laminate
   d. Glass
   e. Solid lumber
   f. Metal

   Core
   a. Solid lumber
   b. Wood blocks
   c. Wood strips
   d. Fiberboard
   e. Volcanic minerals
   f. Foam
   g. Polystyrene
   h. Metal
   i. Lead

ANSWERS TO TEST

6. Answer should include any three of the following

a. Wood	d. Stone
b. Metal	e. Brick
c. Concrete	f. Marble

7. a, d, g, i, j, k, l

8. Explanation should include the following

   a. First two numbers indicate width in feet and inches
   b. Second two numbers indicate height in feet and inches

9. **Clearance**
   a. Top, sides
   b. Bottom

   Dimensions
   a. 7
   b. 11
   c. Other two hinges
   d. 36

10. a. Right-hand reverse (RHR)
    b. Left hand (LH)
    c. Right hand (RH)
    d. Left-hand reverse (LHR)

11. a. Bolt locks
    b. Door pulls, pull plates, push plates, and kick plates
    c. Security bolt lock
    d. Special hinges
    e. Door stops, bumpers, and holders
    f. Surface-mounted door closer
    g. Window hardware
    h. Electrified mortise lock
    i. Panic exit device
    j. Standard door butts
    k. Thresholds
    l. Mortise lock
    m. Electrified cylinder lock
    n. Push-pull latch set
    o. Deadbolt security lock
    p. Tubular lock

ANSWERS TO TEST

q. Cylinder lock
r. Closet rod
s. Shelf brackets and supports
t. Unit lock
u. Concealed floor closer

12. Performance skills evaluated to the satisfaction of the instructor

# RIGGING
UNIT I

UNIT OBJECTIVE

After completing this unit, the student should be able to safely rig and handle different types of loads. The student will show this knowledge by completing assignment sheets, job sheets, and unit test with a minimum schore of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with rigging to their correct definitions
2. Identify accessories used for load lifting.
3. Identify hitches used for attaching materials and equipment to the hoist.
4. Label elements of knots, bends, and hitches.
5. Match types of knots to their correct uses.
6. State safety tips related to rigging.
7. Match types of materials used in construction of ropes to their characteristics.
8. Explain general construction of rope.
9. State precautions to observe when caring for ropes.
10. Calculate safe working load (SWL) of different types and sizes of ropes.
11. State the importance of sling angles.
12. Calculate sling stress.
13. Distinguish among hand signals used in rigging operations.
14. Select from a list characteristics of wire rope construction that affect strength.
15. Match strengths of steel used in wire rope to their grades.
16. Calculate safe working load (SWL) of different sizes of wire ropes.
17. Arrange in order steps to take when performing maintenance on wire rope.
18. Identify types of snatch blocks.

OBJECTIVE SHEET

19. Select from a list types of cable fittings.
20. Identify types of towing chains and accessories.
21. Select from a list good rigging practices.
22. Distinguish among types of knots.
23. Demonstrate the ability to
    a. Tie knots.
    b. Install wire rope clips.
    c. Rig and handle different types of loads using proper hand signals.

RIGGING
UNIT I

SUGGESTED ACTIVITIES

I. Unit contents

- A. Objective sheet
- B. Suggested activities
- C. Transparency masters
  1. TM #1 — Elements of Knots, Bends, and Hitches
  2. TM #2 — Sling Angles
  3. TM #3 — Formula for Calculating Sling Stress
  4. TM #4 — Hoist Signals
  5. TM #5 — Standard Hand Signals for Boom Operation
  6. TM #6 — Standard Hand Signals for Boom Operation (Continued)
  7. TM #7 — Standard Hand Signals for Boom Operation (Continued)
  8. TM #8 — Standard Hand Signals for Boom Operation (Continued)
  9. TM #9 — Maneuvering Vehicles
  10. TM #10 — Wire Rope Fittings
  11. TM #11 — Wire Rope Fittings (Continued)
- D. Information sheet
- E. Assignment sheets
  1. Assignment Sheet #1 — Distinguish Among Types of Knots
  2. Assignment Sheet #2 — Calculate Safe Working Load (SWL) of Different Types and Sizes of Rope
  3. Assignment Sheet #3 — Calculate Sling Stress
  4. Assignment Sheet #4 — Distinguish Among Hand Signals Used in Rigging Operations
  5. Assignment Sheet #5 — Calculate Safe Working Load (SWL) of Different Sizes of Wire Ropes
  6. Assignment Sheet #6 — Identify Poor Rigging Practices

SUGGESTED ACTIVITIES

F. Answers to assignment sheets

G. Job sheets

   1. Job Sheet #1 — Tie Knots

   2. Job Sheet #2 — Install Wire Rope Clips

   3. Job Sheet #3 — Rig and Handle Different Types of Loads Using Proper Hand Signals

H. Test

I. Answers to Test

II. Instructor's guide

A. Review unit and plan presentation.

B. Obtain materials needed to supplement presentation.

   1. Order transparencies and competency profiles.

      (NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W., Washington, DC 20006, phone 202-393-2040.)

   2. Obtain ropes for student practice and rigging equipment for demonstrations.

      (NOTE: Some instructors prefer to use ropes of two different colors to demonstrate knots that join two ropes.)

   3. Obtain posters of rigging knots.

C. Introduce unit.

SUGGESTIONS:

- Visit a construction site or show the class a large picture of a construction site and point out rigging operations in progress and large equipment or material loads that probably required rigging for placement; you may wish to have students see how many rigging requirements they can identify.

SUGGESTED ACTIVITIES

- Assemble some rope and materials, such as three six-foot posts, and ask for students to tie the material so that it can be hoisted.

  (NOTE: Many students will be unable to secure the load, and this will give you the opportunity to motivate them to master skills taught in the unit. However, some of your students may have acquired some rigging skills or at least be familiar with some rigging knots. These students will be able to help you teach knot tying to other students.)

D. Provide students with objective page.

E. Discuss unit and specific objectives, relating the objectives to your introduction to the unit.

F. Provide students with information sheet

G. Discuss information sheet.

1. Use Information Sheet, Section I to discuss terms and definitions associated with rigging.

   SUGGESTIONS:

   - Display examples of equipment and materials when possible.
   - Set up a hoist with block and tackle so that you can relate terms such as *tagline* and *heave* more effectively.
   - Have examples of rope and wire rope cut in cross-section to show *lay*, *core*, and other characteristics.
   - Demonstrate ways of determining the approximate center of gravity of a load.

2. Use Information Sheet, Section II and actual examples of accessories to discuss accessories used for load lifting; demonstrate the use of each.

3. Use Information Sheet, Section III and actual hitches to discuss hitches used to attach materials and equipment to the hoist; demonstrate the use of each type of hitch.

4. Use Information Sheet, Section IV and Transparency 1 to discuss elements of knots, bends, and hitches.

5. Use Information Sheet, Section V to discuss uses of knots.

   SUGGESTIONS:

   - Demonstrate the tying of each type of knot and associate it with an on-the-job application.

SUGGESTED ACTIVITIES

- Provide the students with Job Sheet 1 and allow them to practice tying knots; use skilled students to teach other class members.

- Provide students with Assignment Sheet 1 to allow further practice in identifying knots.

- Emphasize the loss of strength in rope at tie points.

6. Use Information Sheet, Section VI to discuss safety tips related to rigging.

SUGGESTIONS:

- Invite carpenters who have been injured in rigging accidents to discuss their experiences.

- Demonstrate the tips so that students will understand the use of safety snaps, outriggers, heaving, etc.

7. Use Information Sheet, Section VII to discuss characteristics of materials used in rope construction.

SUGGESTIONS:

- Use samples of each type of rope to demonstrate relative strength and stretch characteristics, such as lifting the same size load with each type with some able to lift it and some not.

- Show students samples of worn, weathered, decayed, mildewed, and other defective ropes.

- Discuss size availability, costs, workability, and other factors to consider in choosing rope.

8. Use Information Sheet, Section VIII and an unbraided rope to discuss rope construction.

9. Use Information Sheet, Section IX to discuss precautions to observe when caring for ropes; demonstrate the correct procedures for coiling and uncoiling, washing, storing, and lubricating rope.

10. Use Information Sheet, Section X to discuss calculating SWL of ropes.

SUGGESTIONS:

- Work several problems to show the calculation process.

SUGGESTED ACTIVITIES

- Relate the constants to the relative strengths discussed in Section VII.

- Provide students with Assignment Sheet 2 to allow practice computing SWLs.

11. Use Information Sheet, Section XI and Transparency 2 to discuss the importance of sling angles.

    SUGGESTIONS:

    - Use a sling to demonstrate what is meant by sling angles; show two-, three-, and four-legged slings; point out that various sources refer to sling angle as that between rope and horizontal, while others use between rope and vertical.

    - Use the concept of critical angle to show how the strength of a sling may be increased by increasing the angle or by increasing the number of legs; use the concept to introduce the next section.

12. Use Information Sheet, Section XII to discuss calculating sling stress.

    SUGGESTIONS:

    - Emphasize that the sling stress value will be the same unit of measure as that used for W and that L and H must be expresssed in the same unit of measure for the formula to work.

    - Provide students with Assignment Sheet 3 to allow practice calculating sling stress.

13. Use Information Sheet, Section XIII and Transparencies 4-9 to discuss hand signals used in rigging operations.

    SUGGESTIONS:

    - Demonstrate the hand signals using model cranes to illustrate the operator's responses.

    - Divide the class into two-student teams to study hand signals and then have the teams compete against each other with one team member being the signaller and the other being the operator.

    - Provide students with Assignment sheet 4 to allow practice with hand signals.

14. Use Information Sheet, Section XIV to discuss characteristics of wire rope construction; show the students examples of various types of wire rope and relate their construction to their suitability for various applications.

SUGGESTED ACTIVITIES

15. Use Information Sheet, Section XV to discuss grades and strengths of steel used in wire rope.

    SUGGESTIONS:

    - Compare costs of each type of wire rope steel.
    - Discuss availability and use of various steels and size of wire rope.

16. Use Information Sheet, Section XVI to discuss calculating SWL for wire ropes.

    SUGGESTIONS:

    - Demonstrate several calculations.
    - Compare the formula to the formula for rope.
    - Provide students with Assignment Sheet 5 to allow practice calculating SWL for wire ropes.

17. Use Information Sheet, Section XVII to discuss maintenance of wire rope.

    SUGGESTIONS:

    - Show samples of worn and corroded wire ropes.
    - Demonstrate the care techniques.

18. Use Information Sheet, Section XVIII to discuss types of snatch blocks; use actual snatch blocks and demonstrate their use.

19. Use Information Sheet, Section XIX and Transparencies 10 and 11 to discuss types of cable fittings.

    SUGGESTIONS:

    - Exhibit examples of the various types of fittings; demonstrate installation of each type.
    - Provide students with Job Sheet 2 and allow them to practice procedures

20. Use Information Sheet, Section XX to discuss towing chains and accessories; show examples of each and discuss their use.

21. Use Information Sheet, Section XXI to discuss good rigging practices.

    SUGGESTIONS:

    - Demonstrate procedures listed.

SUGGESTED ACTIVITIES

- Provide students with Job Sheet 3 and allow students to practice procedures; expand job sheet to include rigging practices listed, having students rig load and signal crane operator.
- Provide students with Assignment Sheet 6 and encourage open discussion of rigging practices.

H. Review unit.

I. Give test.

J. Critique and discuss test with students.

K. Reteach and retest as required.

L. Complete appropriate sections of competency profiles.

III. Unit references

A. Smith, Earl L. *Power Line Technician's Training.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and Rural Electric Cooperatives of Oklahoma, 1978.

B. Hendrix, Laborn J. "Bud." *Millwright Instructional Materials.* Stillwater, Oklahoma: Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center and The Associated General Contractors of America, 1980.

C. Newberry, W.G. (Bill). *Handbook for Riggers.* 2nd ed. Canada: Newberry, 1977.

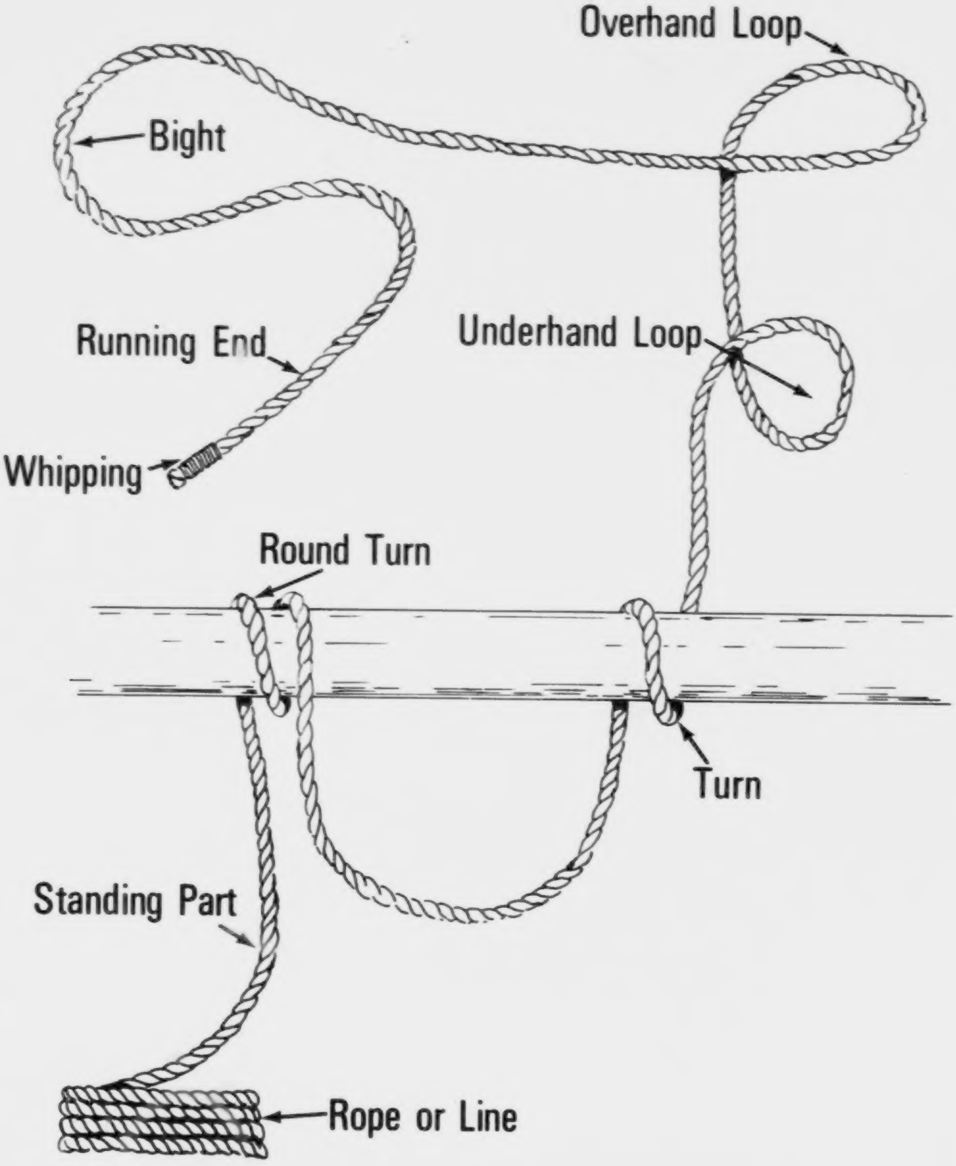
(NOTE: Address requests for handbook to W.G. (Bill) Newberry; P.O. Box 2999; Calgary, Alberta, Canada T2P 2M7.)

D. Nichols, Herbert L., *Moving the Earth.* 3rd ed. Greenwich, Connecticut: North Castle Books, 1976.

E. Nichols, Herbert L., Jr. *Heavy Equipment Repair.* Greenwich, Connecticut: North Castle Books, 1964.

F. Rossnagel, W.E. *Handbook of Rigging.* 3rd ed. New York: McGraw-Hill Book Company, 1964.

Elements of Knots, Bends, and Hitches

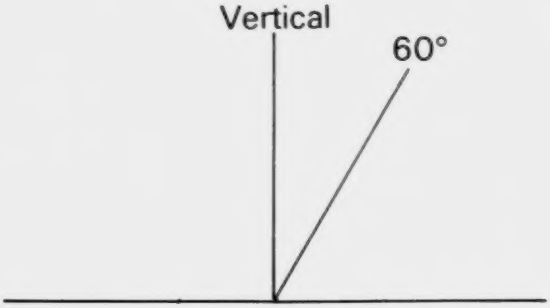

Overhand Loop
Bight
Running End
Underhand Loop
Whipping
Round Turn
Turn
Standing Part
Rope or Line

Sling Angles

Critical Angle--Sling Angle that Exists when the Tension in the Sling Leg Equals the Weight of the Load

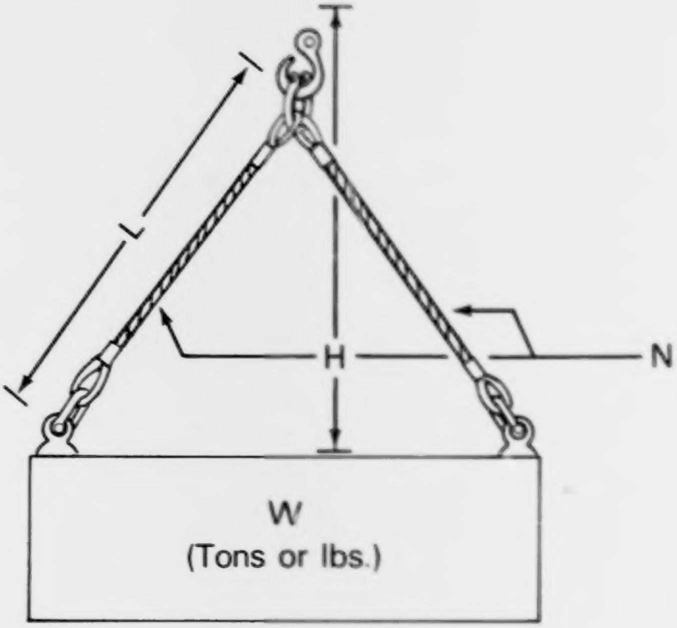
Critical Angle Formula

$$CA = \frac{60^\circ}{N}$$



N = Number of Sling Legs

Formula for Calculating Sling Stress



$S = \frac{W \times L}{H \times N}$

$S = \frac{10 \times 6}{2 \times 4}$

$S = \frac{60}{8}$

S = 7½ Tons

W=10 Weight

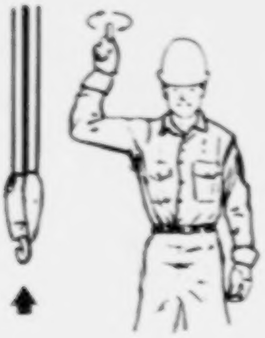
L=6' Length

H=4' Height

N=2 No. of Sling Legs

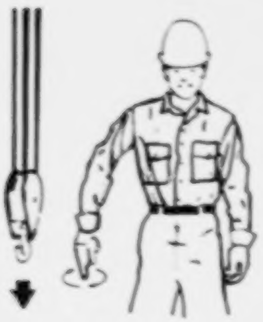
Hoist Signals

Hoist the Load



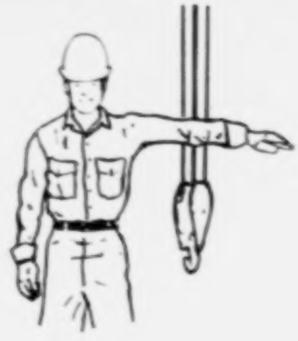
Forearm vertical, forefinger pointing up, move hand in small, horizontal circle

Lower the Load



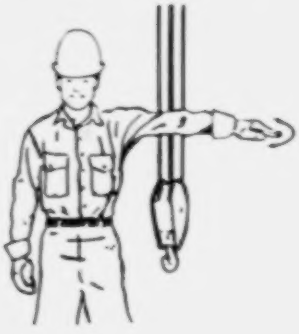
Arm extended downward, forefinger pointing down, move hand in small, horizontal circle

Stop



Arm extended, palm down, hold position rigidly

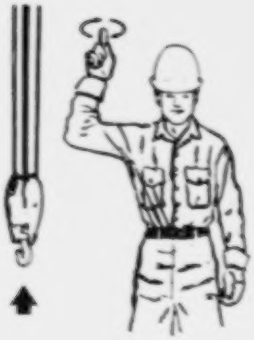
Emergency Stop



Arm extended, palm down, move hand rapidly right and left

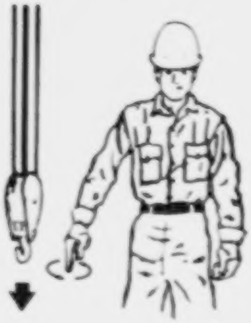
Standard Hand Signals for Boom Operation

Hoist



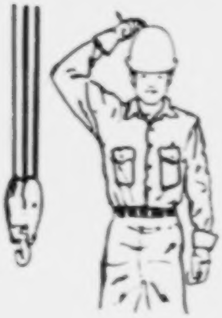
Forearm vertical, forefinger pointing up, move hand in small, horizontal circle

Lower



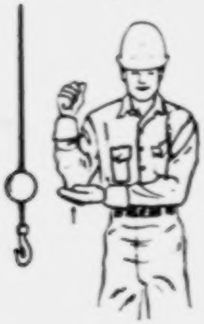
Arm extended downward, forefinger pointing down, move hand in small horizontal circles

Use Main Hoist



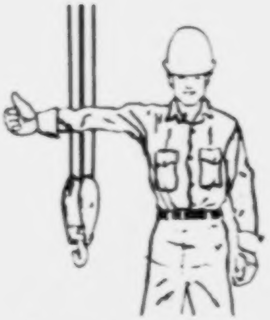
Tap fist on head then use regular signals

Use Whipline



Tap elbow with one hand then use regular signals

Raise Boom

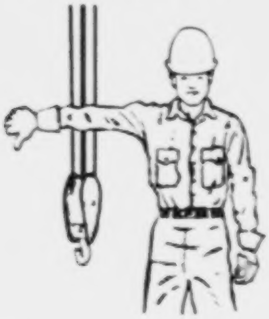


Arm extended, fingers closed, thumb pointing upward

Standard Hand Signals for Boom Operation

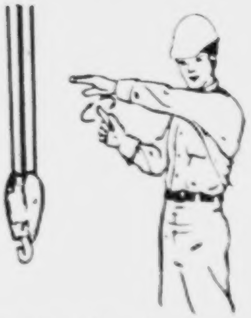
(Continued)

Lower Boom



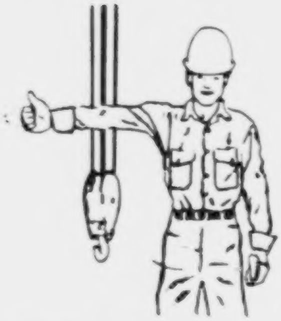
Arm extended, fingers closed, thumb pointing downward

Move Slowly



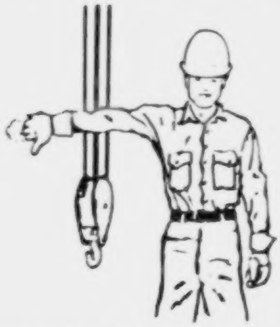
Use one hand to give any motion signal and place other hand motionless in front of hand giving the motion signal (hoist slowly shown as example)

Raise the Boom and Lower the Load



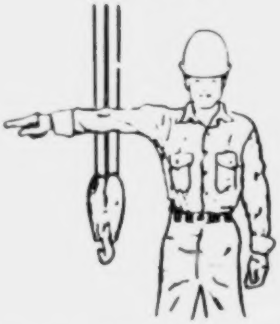
Arm extended, thumb pointing up, flex fingers in and out as long as load movement is desired

Lower the Boom and Raise the Load



Arm extended, thumb pointing down, flex fingers in and out as long as load movement is desired

Swing

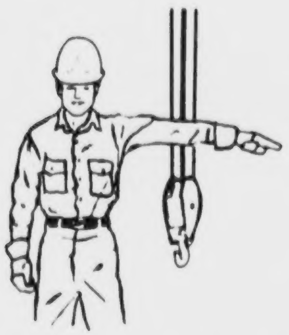


Arm extended, point with finger in direction of swing of boom

Standard Hand Signals for Boom Operation

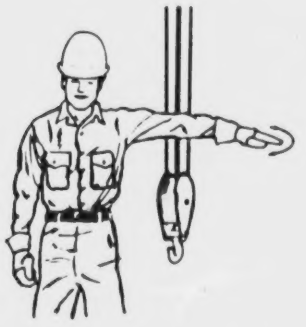
(Continued)

Stop



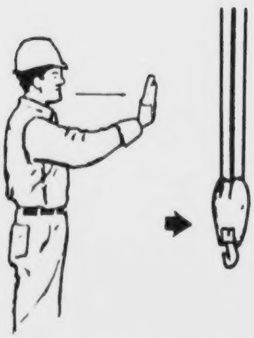
Arm extended, palm down
hold position rigidly

Emergency Stop



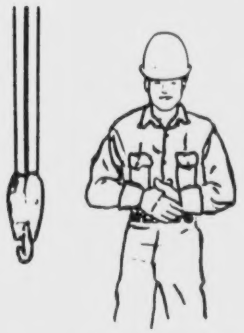
Arm extended, palm down,
move hand rapidly right and
left

Travel



Arm extended forward, hand
open and slightly raised, make
pushing motion in direction
of travel

Dog Everything

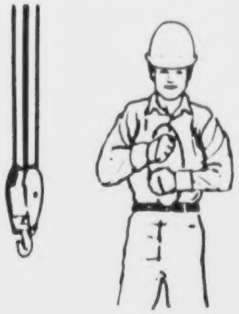


Clasp hands in front of body

Standard Hand Signals for Boom Operation

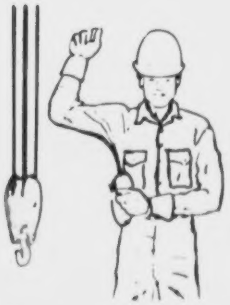
(Continued)

Travel (both tracks)



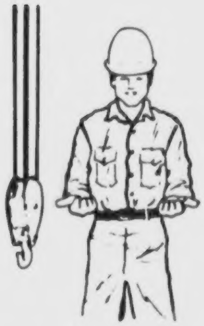
Use both fists in front of body, making a circular motion about each other indicating direction of travel: forward or backward (crawler cranes only)

Travel (one track)



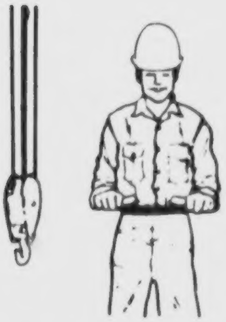
Lock the track on side indicated by raised fist, travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body (for crawler cranes only)

Extend Boom



Both fists in front of body with thumbs pointing outward

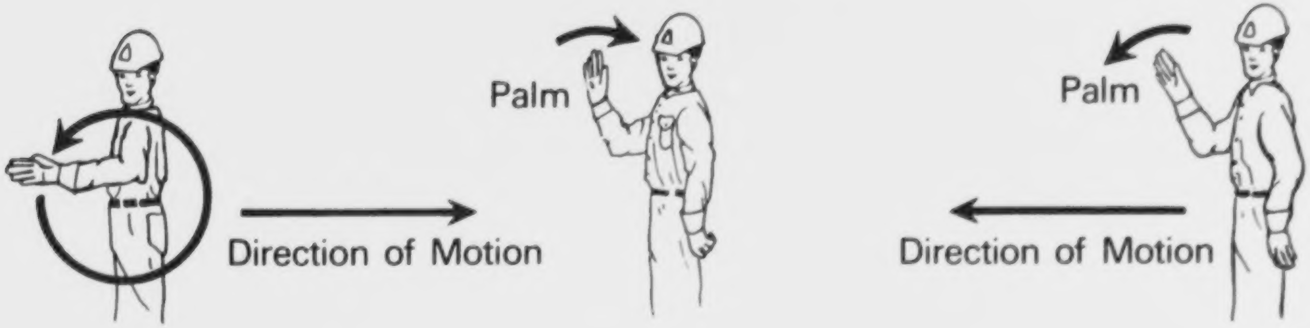
Retract Boom



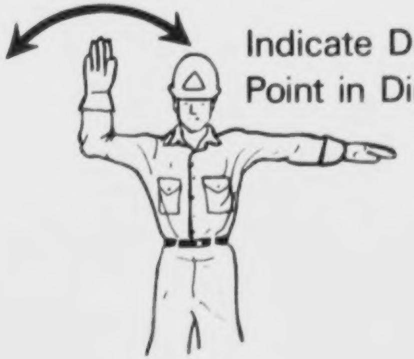
Both fists in front of body with thumbs pointing toward each other

Maneuvering Vehicles

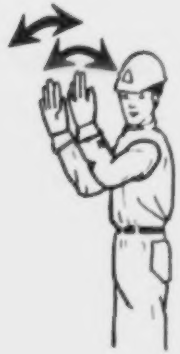
Move


Palm
Palm
Direction of Motion
Direction of Motion

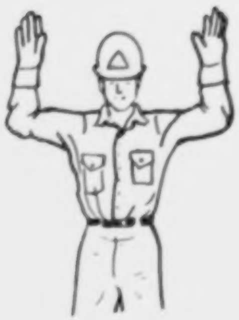
Turn While Moving


Indicate Direction
Point in Direction of Turn

Straighten Out



Stop

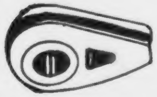


TM #9

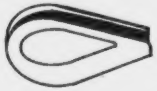
CC-27-D

Wire Rope Fittings

Standard Solid Thimble

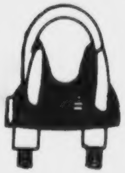


Standard Hawser Thimble

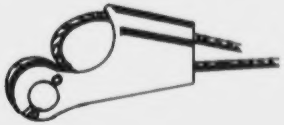


THE ASSOCIATED GENERAL CONTRACTORS OF AMERICA
AGC

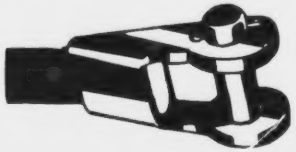
Drop Forged Clip



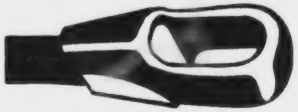
Open Wedge Socket



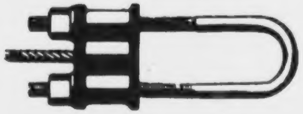
Open Socket for Flat



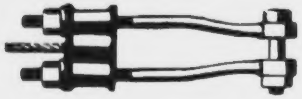
Closed Socket for Flat Rope



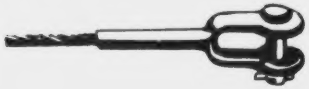
Closed-type Bridge Socket



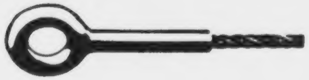
Open-type Bridge Socket



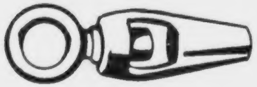
Swaged Clevis Fitting



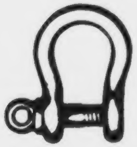
Swaged Round Eye Fitting



Swivel Eye and Socket

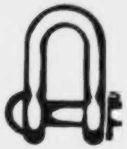


Screw Pin Shackle

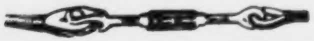


Wire Rope Fittings
(Continued)

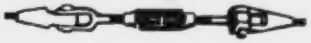
Standard Shackle



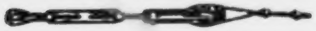
Turnbuckle with Spliced Rope



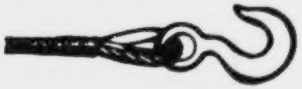
Turnbuckle with Socketed Rope



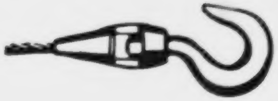
Turnbuckle with Clipped Rope



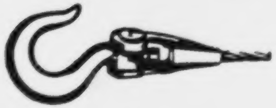
Drop Forged Steel Hook with Thimble



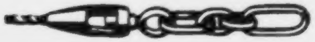
Drop Forged Steel Swivel Hook and Socket



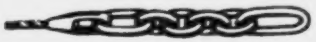
Logging Swivel Hook and Socket with Double Swivel



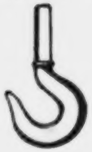
Swivel Eye Socket with Chain



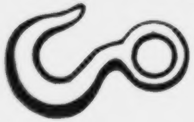
Closed Socket with Chain



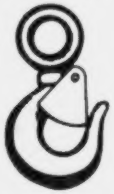
Drop Forged Steel Hook with Shank



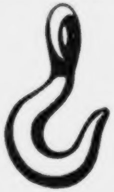
Drop Forged Steel Hook with Eye



Safety Snap Hook



Reversed Eye Hook



RIGGING
UNIT I

INFORMATION SHEET

I. Terms and definitions

A. Rigging — Setting up block and tackle to a winch, stacking and hoisting material and equipment, or replacing cables on equipment

B. Hitch — To attach a rope to a post, pole, ring, hook, or other object

C. Tagline — Rope used to guide or steady load while being lifted

D. Heave — To pull from underneath the load

E. Tackle — Assembly of blocks and lines used to gain a mechanical advantage in lifting

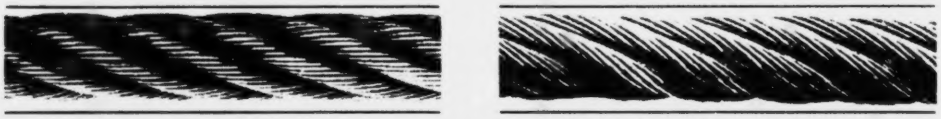
F. Sheave — Grooved wheel or pulley

G. Preforming — Preliminary shaping of wires so that they will lie in place

H. Lay — Direction, length, or angle of twist of strands in a rope or cable (Figure 1)

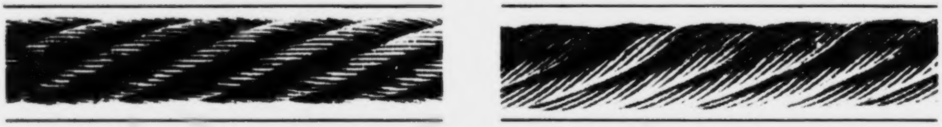
EXAMPLES:

FIGURE 1



Right, regular-lay rope

Right, Lang-lay wire rope



Left, regular-lay rope

Left, Lang-lay wire rope

I. Snatch block — Pulley in a cast that can be easily fastened to lines or objects by means of a hook, ring, or shackle

J. Core — Material used in the center of wire rope

K. Spreaders — Devices used to prevent crushing of load and to lift extra long and heavy loads

L. psi — Pounds per square inch

M. Center of gravity — Point at which entire weight may be considered as concentrated

INFORMATION SHEET

N. Eye — Metal loop which engages a hook

O. Thimble — Grooved metal ring inserted in loop of rope to prevent wear

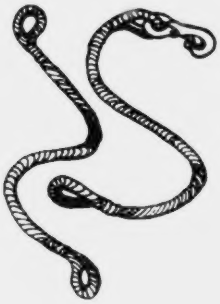
P. Dog — Slang meaning to deliberately slow down the work pace

Q. Splice — To join two sections of rope or cable together to form a continuous length

II. Accessories used for load lifting (Figures 2-8)

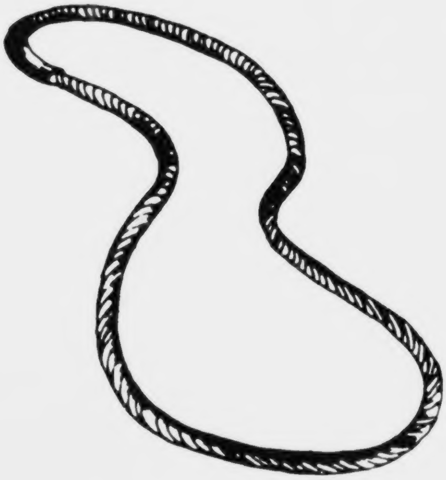
A. Choker (single sling)

FIGURE 2



B. Grommet sling

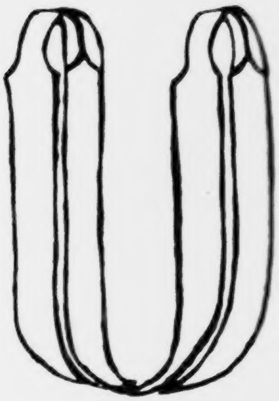
FIGURE 3



INFORMATION SHEET

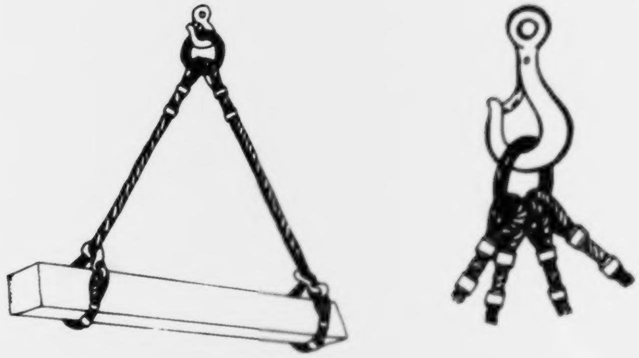
C. Web sling

FIGURE 4



D. Bridle

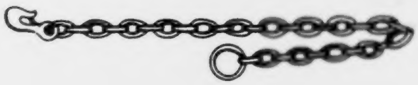
FIGURE 5



E. Bull chain

(NOTE: Chains are used mainly for towing and for securing equipment.)

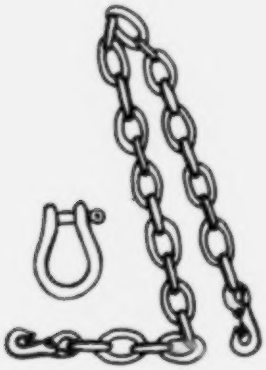
FIGURE 6



INFORMATION SHEET

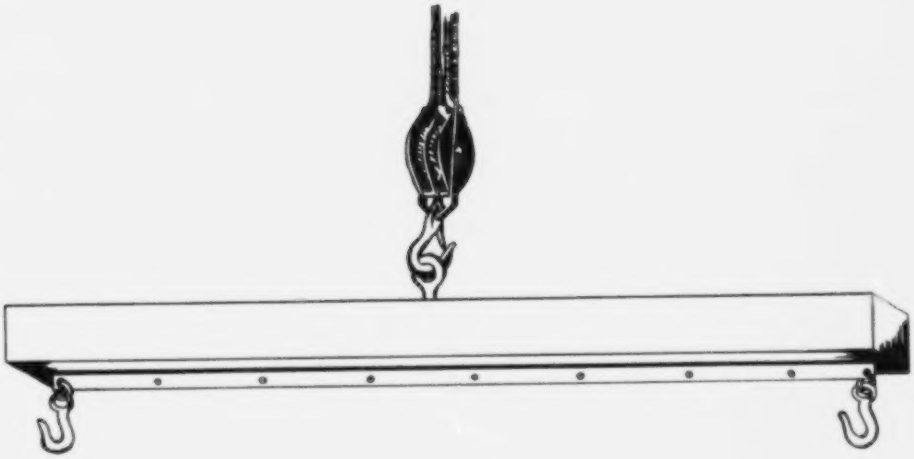
F. Chain and shackle

FIGURE 7



G. Spreader bars

FIGURE 8



INFORMATION SHEET

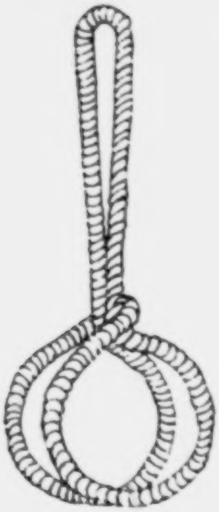
III. Hitches used to attach materials and equipment to the hoist (Figures 9-13)

CAUTION

The placement of hitches on the load is very critical. Caution must be taken to be sure hitches are made secure and safe.)

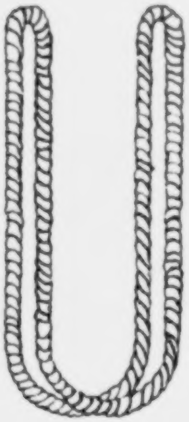
A. Choker hitch sling

FIGURE 9



B. Basket hitch sling

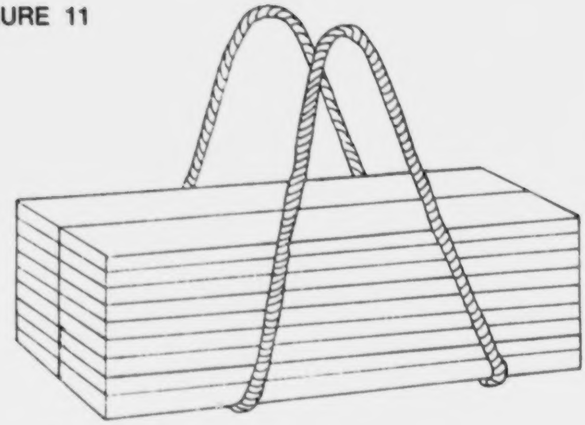
FIGURE 10



INFORMATION SHEET

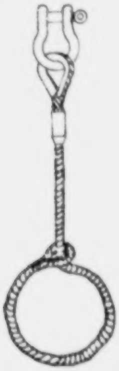
C. Inverted basket hitch sling

FIGURE 11



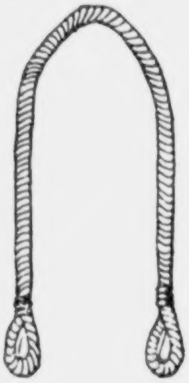
D. Choker hitch choker

FIGURE 12



E. Basket hitch choker

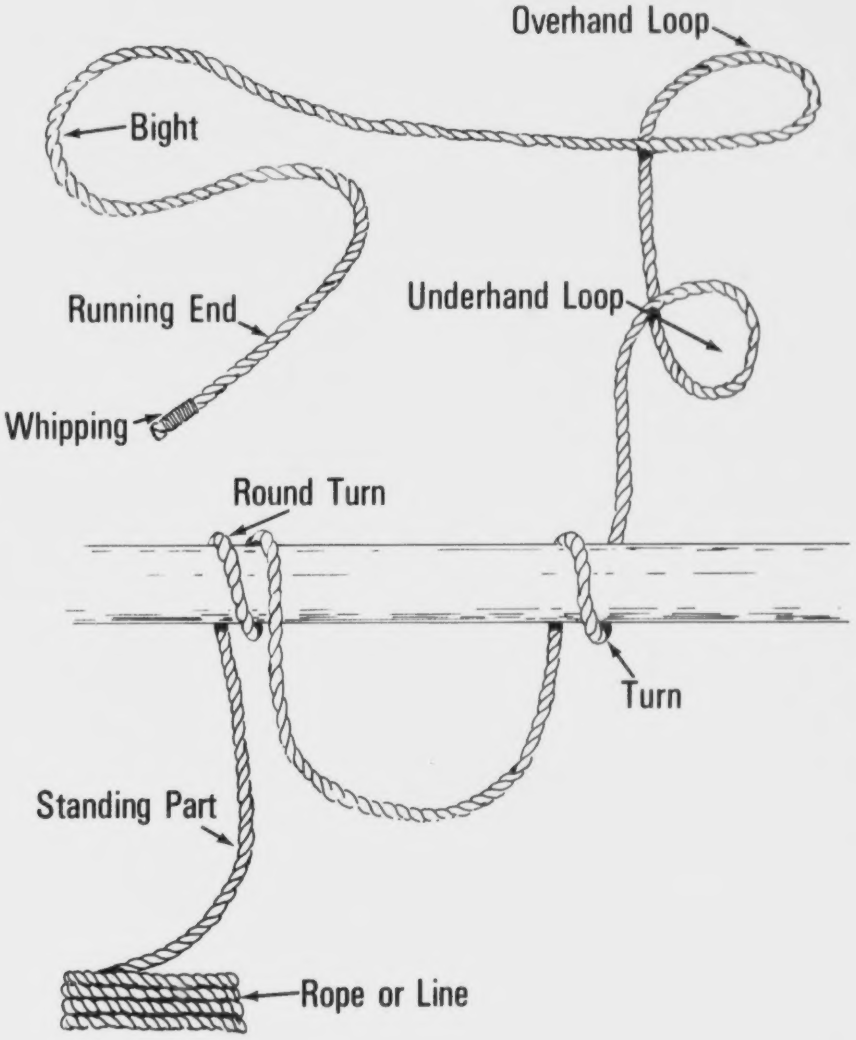
FIGURE 13



INFORMATION SHEET

IV. Elements of knots, bends, and hitches (Figure 14)

FIGURE 14


Overhand Loop
Bight
Running End
Underhand Loop
Whipping
Round Turn
Turn
Standing Part
Rope or Line

INFORMATION SHEET

V. Correct uses of types of knots (Figures 15-25)

(NOTE: Efficiency of manila rope decreases considerably when using knots and splices.)

EXAMPLE: Straight rope = 100% strength

Eye splice = 85% strength

Clove hitch = 75% strength

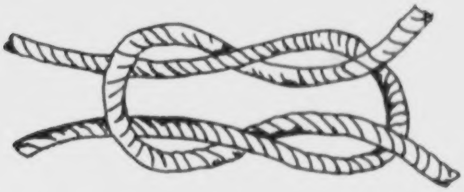
Bowline = 53% strength

Square knot = 43% strength

Sheepshank = 35% strength

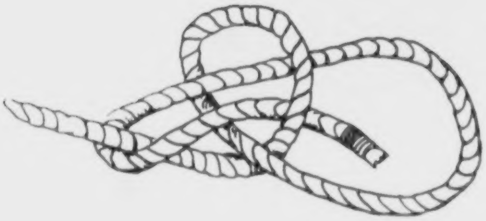
A. Square knot — Ties two lines of equal size together so that they will not slip

FIGURE 15



B. Bowline — Forms a single loop that will not tighten or slip under strain

FIGURE 16

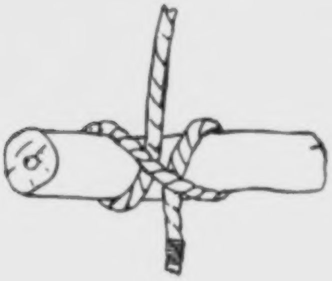


INFORMATION SHEET

C. Clove hitch — Fastens a line to timber or pipe

(NOTE: This is probably one of the most widely used knots.)

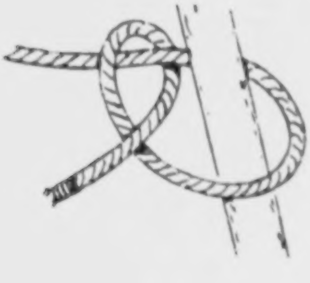
FIGURE 17



D. Half hitch — Ties line to timber or a larger line

(NOTE: This a quick and easy knot to use when tying down a tarp or plastic covering.)

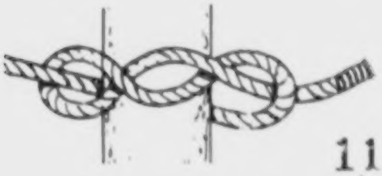
FIGURE 18



E. Timber hitch — Holds timber securely when moving heavy timber or poles

(NOTE: Because of the pressure of one coil over the other; the more tension that is applied, the tighter the hitch becomes.)

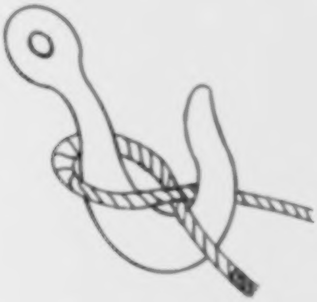
FIGURE 19



INFORMATION SHEET

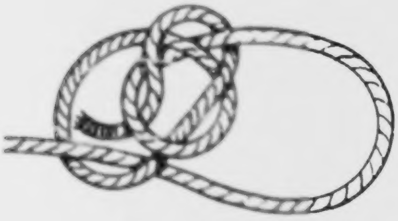
F. Blackwall hitch — Fastens a line to a hook; generally used temporarily

FIGURE 20



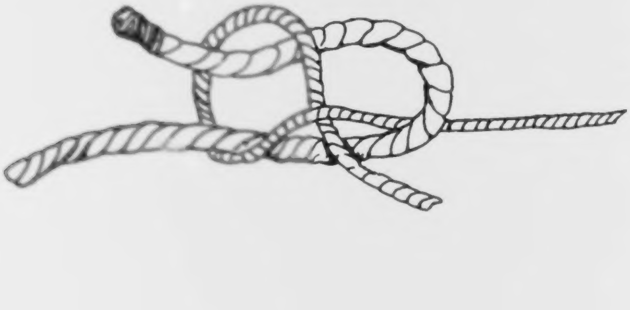
G. Running bowline — Forms a strong running loop which is convenient for running an eye; can also provide a choker-type sling at the end of a line

FIGURE 21



H. Sheet bend — Ties two lines of unequal size together; also used to tie a line to an eye

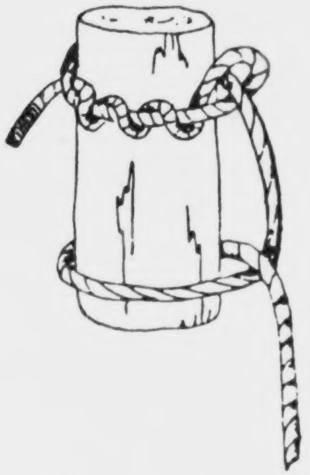
FIGURE 22



INFORMATION SHEET

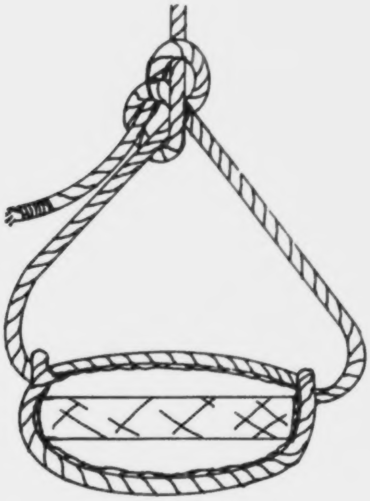
I. Timber hitch with half hitch — Holds heavy timbers or poles for lifting or dragging

FIGURE 23



J. Scaffold hitch — Supports ends of scaffold plank and prevents it from tilting

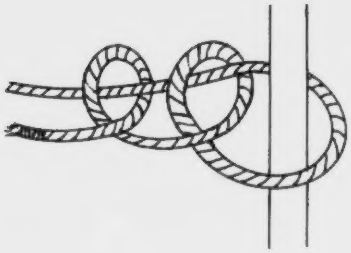
FIGURE 24



INFORMATION SHEET

K. Two half hitches — Secure running end of line to standing part

FIGURE 25



VI. Safety tips related to rigging

A. Use personal protective devices such as goggles, gloves, safety shoes, and hard hats

B. Use tagline to guide or steady load

C. Do not walk under load

D. Be sure load is balanced properly

E. Do not overload equipment

F. Use corner saddles, padding, or wood blocking to protect slings from sharp bends and sharp edges

G. Stand clear when slings are heaved from under loads

H. Avoid heavy or continous overloading

I. Be sure outriggers or stabilizers are in use and are on solid footing

J. Lubricate slings to prevent rust

K. Be sure all hooks have safety snaps

L. Be extra cautious around power lines

CAUTION

There must be a minimum of ten feet between equipment and power lines. Check local requirements.

INFORMATION SHEET

VII. Characteristics and types of materials in construction of ropes

A. Manila — Strong and durable; used where dependability, ability to stand up under severe use, and resistance to weathering are required

B. Sisal — Low durability and strength; low cost

(NOTE: Manila and sisal are natural materials. The remaining materials listed are man-made.)

C. Nylon — Very strong, high abrasion resistance, good resistance to weathering, and high degree of stretch

(NOTE: Nylon rope is approximately twice as strong as manila rope of the same diameter.)

D. Polyester (terylene or dacron) — Less strength than nylon; little stretch

E. Polypropylene — Slightly less strength than nylon; little stretch; very light, actually floats on water; resistant to rot

F. Polyethylene — Less strength than nylon; high stretch; excellent resistance to mildew, decay, acids, and alkalies

VIII. General construction of rope

A. Rope is normally made of three strands, each of which is made of several threads

B. The rope itself is twisted in a right-hand direction while each strand is twisted in a left-hand direction and the individual threads are twisted in a right-hand direction

C. Reversal of twist in strands gives the rope a balance or set which eliminates the tendency to unwind

IX. Precautions to observe when caring for ropes

A. When taking rope from a coil, always remove it from the center in a counterclockwise direction

B. When rope is not in use, it should be re-coiled in a clockwise direction

C. When rope is attached to a hook, ring, or pulley block, a thimble should be placed in the loop or eye to reduce wear and to decrease stress

D. Protect rope from moisture and weather as much as possible

E. Do not disturb a frozen rope until completely thawed

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F. Keep rope away from acids, other chemicals, and heat

G. Do not drag rope over ground or sharp edges

H. If possible, do not make abrupt bends in ropes

I. Dirty rope should be washed and dried before being stored

J. Store rope so that air may circulate around it

(NOTE: Hang rope in loose coils or place on wood grating above the floor.)

K. If manila rope becomes stiff and hard because of being wet, treat with a thin lubricating oil or warm petrolatum (a jelly-like petroleum-based dressing.)

(NOTE: This can be accomplished by applying the lubricant with a paint brush.)

X. Formulas for calculating safe working load (SWL) of different types and size of ropes

(NOTE: Each formula uses its own mathematical constant, a number assumed to have one value throughout the particular formula.)

A. Convert diameter of rope to eights of an inch

B. Square the numerator of the fraction (that is, multiply the numerator times itself)

C. Multiply the numerator squared by the constant for the type of rope being used; see Table 1

TABLE I — Safe Working Load Constants for Various Types of Rope

Type of Rope	Constant
Manila	20
Nylon or polyester	60
Polypropylene	40
Polyethylene	35

EXAMPLES: 1. What is the SWL of $^1/_2$" manila rope?

$^1/_2 = {}^4/_8$

$4 \times 4 = 16$

$16 \times 20 = 320$ lbs.

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2. What is the SWL of 3/4" nylon rope?

   3/4" = 6/8"

   6×6 = 36

   36×60 = 2160 lbs.

3. What is the SWL of 1" polyethylene rope?

   1" = 8/8"

   8×8 = 64

   64×35 = 2240 lbs.

XI. Importance of sling angles

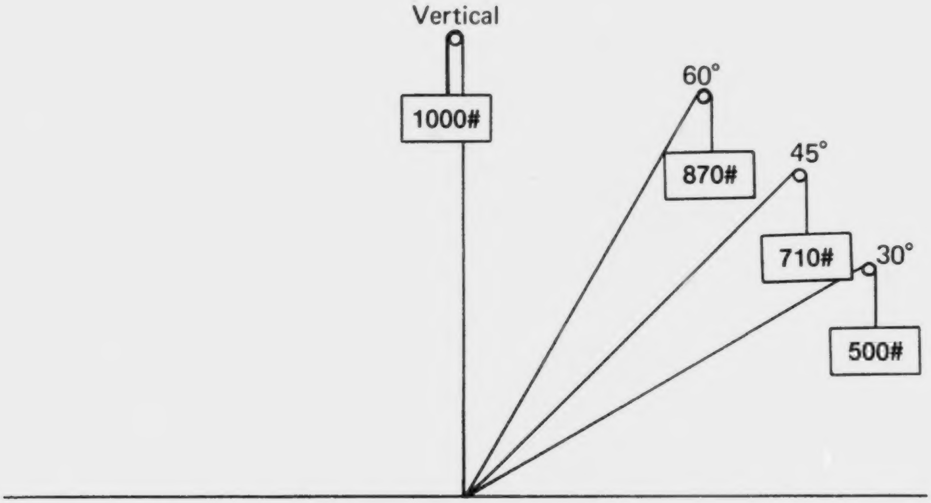
   A. Decreasing angle of sling leg increases the stress on the sling

   B. As the angle is reduced, lifting capacity is reduced very rapidly

      (NOTE: When the single leg of the sling is at a 60° angle, the lifting capacity is only 87 percent of a vertical leg. At a 45° angle, the lifting capacity is 71 percent of that of vertical leg, while at a 30° angle, the lifting capacity is 50 percent of that of a vertical leg. See Figure 26.)

      EXAMPLE:

FIGURE 26



INFORMATION SHEET

XII. Formula for calculating sling stress (Figure 27)

$$\text{Sling stress} = \frac{W \times L}{H \times N}$$

FIGURE 27

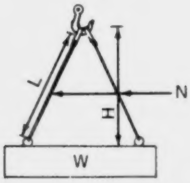
W = Weight of load

L = Length of sling

H = Height of load

N = Number of sling legs

EXAMPLE:



W = 10 tons
L = 6′
H = 4′
N = 2

$$\frac{10 \times 6}{4 \times 2} = \frac{60}{8} = 7\tfrac{1}{2}$$

(NOTE: Weight can be in pounds or tons or metric weights. Whichever is used will be the same unit of measure that the sling stress is given in. L and H can be in any unit of measure of length—inches, feet, meters—as long as they are both stated in the same unit of measure.)

XIII. Hand signals used in rigging operations (Figures 28-53)

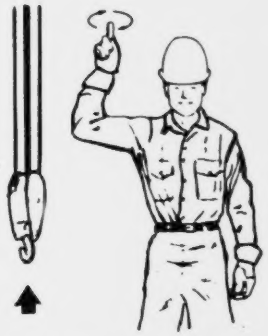
A. Hoist operations

1. Hoist the load

(NOTE: Raise forearm vertical, forefinger pointing up; move hand in small, horizontal circle.)

INFORMATION SHEET

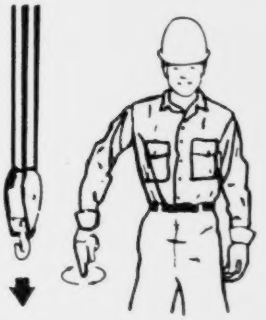
FIGURE 28



2. Lower the load

   (NOTE: Extend arm downward, forefinger pointing down; move hand in small, horizontal circle.)

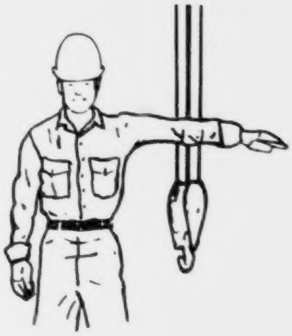
FIGURE 29



3. Stop

   (NOTE: Extend arm, palm down, and hold rigid.)

FIGURE 30

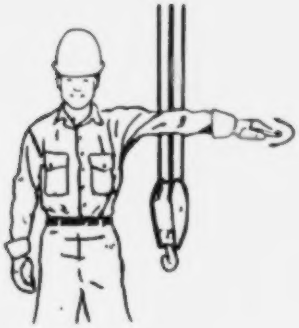


INFORMATION SHEET

4. Emergency stop

(NOTE: Extend arm, palm down; move hand rapidly right and left.)

FIGURE 31

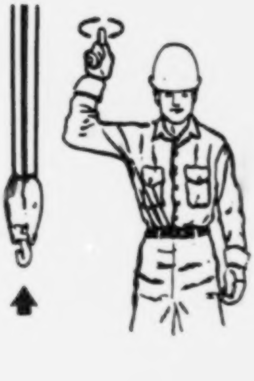


B. Boom operation

1. Hoist

(NOTE: Raise forearm vertical, forefinger pointing up; move hand in small, horizontal circle.)

FIGURE 32

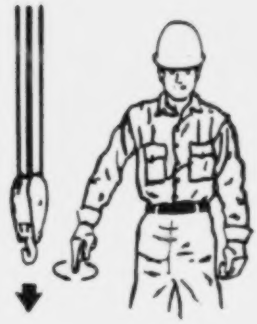


2. Lower

(NOTE: Extend arm downward, forefinger pointing down; move hand in small horizontal circles.)

INFORMATION SHEET

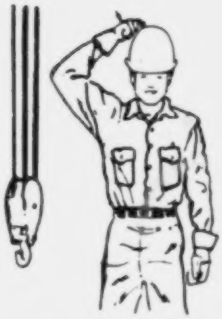
FIGURE 33



3. Use main hoist

(NOTE: Tap first on head, then use regular signals.)

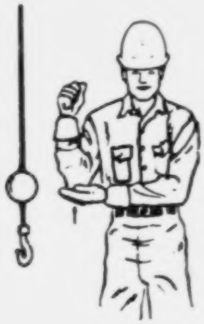
FIGURE 34



4. Use whipline

(NOTE: Tap elbow with one hand, then use regular signals.)

FIGURE 35

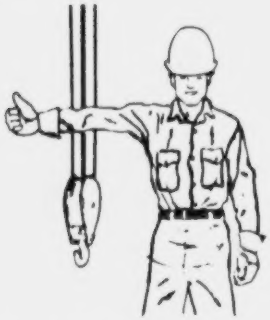


INFORMATION SHEET

5. Raise boom

(NOTE: Extend arm with fingers closed; point thumb up.)

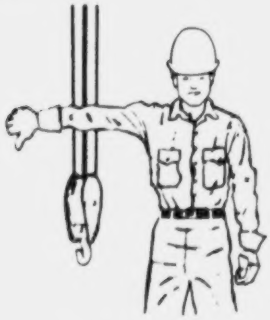
FIGURE 36



6. Lower boom

(NOTE: Extend arm with fingers closed; point thumb down.)

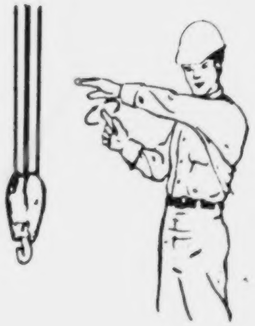
FIGURE 37



7. Move slowly

(NOTE: Use one hand to give any signal and place other hand motionless in front of hand giving the motion signal. Hoist slowly is shown as an example.)

FIGURE 38

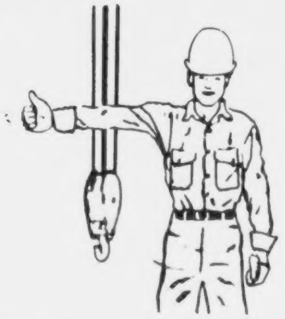


INFORMATION SHEET

8. Raise the boom and lower the load

(NOTE: Extend arm with thumb pointing up; flex fingers in and out as long as load movement is desired.)

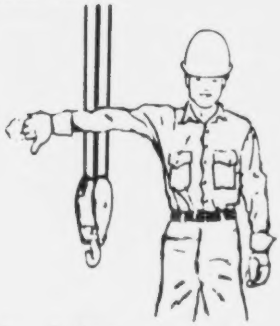
FIGURE 39



9. Lower the boom and raise the load

(NOTE: Extend arm with thumb pointing down; flex fingers in and out as long as load movement is desired.)

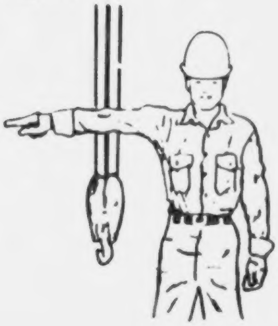
FIGURE 40



10. Swing

(NOTE: Extend one arm and point with finger in direction of swing of boom.)

FIGURE 41

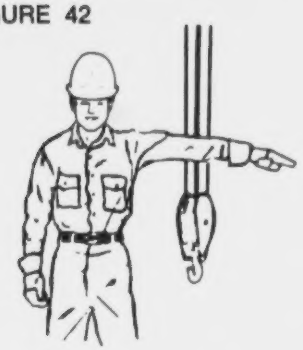


INFORMATION SHEET

11. Stop

(NOTE: Extend arm with palm down; hold rigid.)

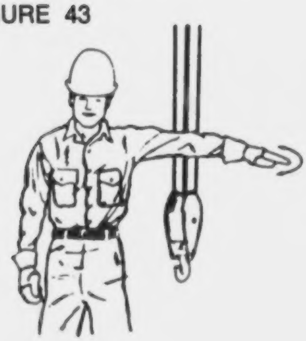
FIGURE 42



12. Emergency stop

(NOTE: Extend arm with palm down; move hand rapidly right and left.)

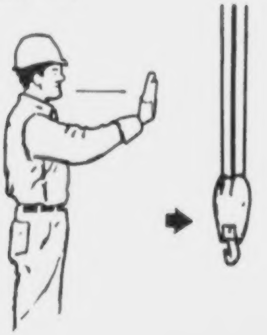
FIGURE 43



13. Travel

(NOTE: Extend arm forward with hand open and slightly raised; make pushing motion in direction of travel.)

FIGURE 44

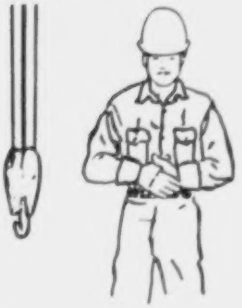


INFORMATION SHEET

14. Dog everything

(NOTE: Clasp hand in front of body.)

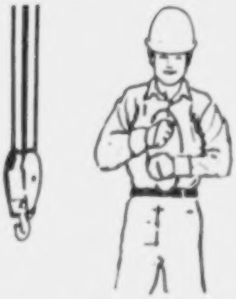
FIGURE 45



15. Travel (both tracks)

(NOTE: Use both fists in front of body, making a circular motion about each other indicating direction of travel [forward or backward, crawler cranes only].)

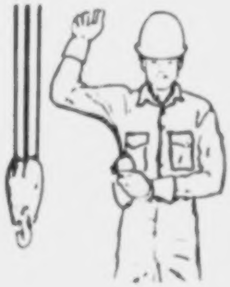
FIGURE 46



16. Travel (one track)

(NOTE: Lock the track on side indicated by raised fist; travel opposite track in direction indicated by circular motion of other fist, rotated vertically in front of body [crawler cranes only].)

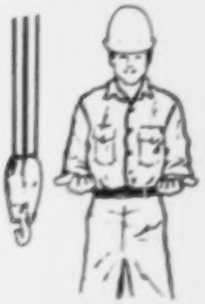
FIGURE 47



17. Extend boom

(NOTE: Raise both fists in front of body with thumbs pointing outward.)

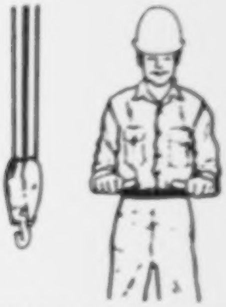
FIGURE 48



18. Retract boom

(NOTE: Raise both fists in front of body with thumbs pointing toward each other.)

FIGURE 49

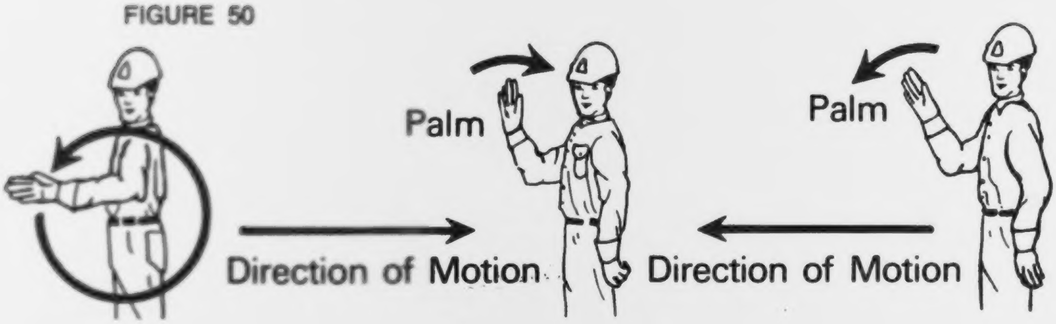


C. Vehicle maneuvering

1. Move (forward or backward)

(NOTE: Move one arm in circular motion at elbow and then hold at side; extend other arm with hand flat and bend at elbow in direction of desired movement.)

FIGURE 50

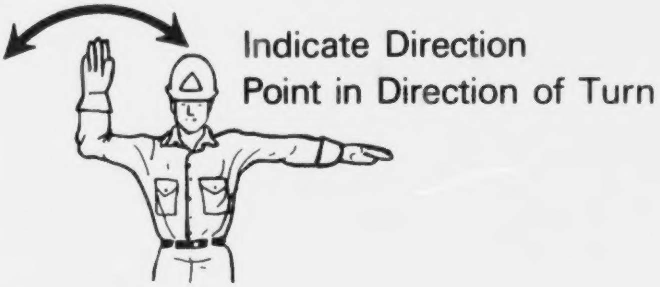

Palm
Palm
Direction of Motion
Direction of Motion

INFORMATION SHEET

2. Turn while moving

   (NOTE: Extend one arm, palm down, in direction of turn and hold rigid; raise other arm at elbow and wave hand back and forth.)

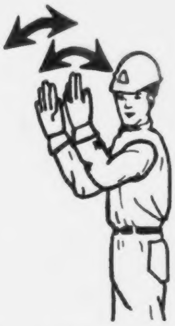
FIGURE 51


Indicate Direction
Point in Direction of Turn

3. Straighten out

   (NOTE: Turn side toward operator and extend arms in front, bent up at elbows; move hands back and forth.)

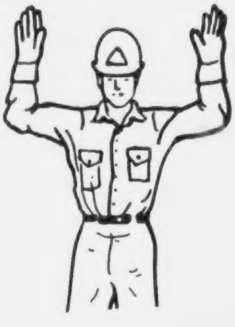
FIGURE 52



4. Stop

   (NOTE: Hold both arms out to side bent up at elbows, with palms toward operator and held rigid.)

FIGURE 53



INFORMATION SHEET

XIV. Characteristics of wire rope construction that affect strength (Figure 54)

A. Size of wire in strand

B. Grade of steel wire used

C. Number of wires in each strand

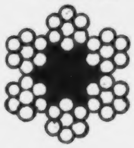
D. Number of strands

E. Type of core

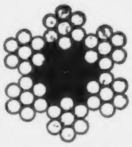
F. Preformed lay

EXAMPLES:

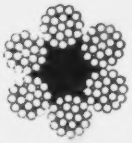
FIGURE 54



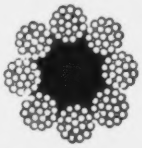
1. 6 x 7 coarse laid



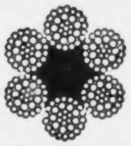
2. 6 x 19 Seale



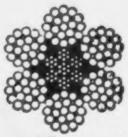
3. 6 x 19 modified Seale



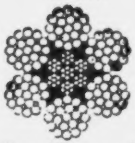
4. 8 x 19 modified Seale



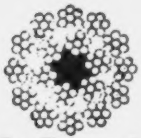
5. 6 x 37 extra pliable



6. 6 x 19 modified Seale with independent wire rope core, Lang-lay



7. 6 x 19 regular lay with independent wire rope center



8. 8 x 7 nonrotating

XV. Grades and strengths of steel used in wire rope

A. Iron Wire - 100,000 psi

B. Traction steel — 180,000 to 190,000 psi

C. Mild plow steel — 200,000 to 220,000 psi

D. Plow steel — 220,000 to 240,000 psi

E. Improved plow steel — 240,000 to 260,000 psi

F. Special improved steel — 260,000 to 280,000 psi

INFORMATION SHEET

XVI. Formula for calculating safe working loads (SWL) of different sizes of wire ropes

(NOTE: Compute in tons. The number 8 is a mathematical constant.)

EXAMPLE: $\frac{1}{2}$″ diameter rope

$\frac{1}{2} \times \frac{1}{2} \times 8 = 2$ tons

XVII. Steps to take when performing maintenance on wire rope

(NOTE: Frequent application of proper lubricant to exterior of rope is necessary to help retain lubricant within the rope.)

A. Check for frayed and worn wires

B. Heat oil that is recommended by manufacturer

(NOTE: Apply oil while thin so that it will penetrate into the center of rope.)

C. Apply oil by moving rope through a long pan

D. Wipe off surplus oil as rope leaves the pan

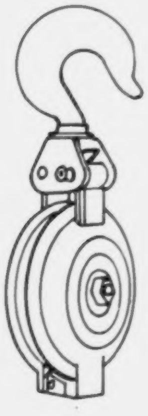
E. Allow oil to cool and thicken

XVIII. Types of snatch blocks (Figures 55-60)

(NOTE: Snatch blocks are used to increase the force exerted by a line when hoisting and dragging.)

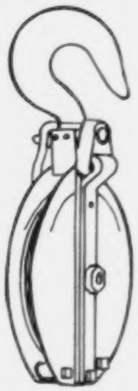
A. Swivel hook

FIGURE 55



B. Self-locking

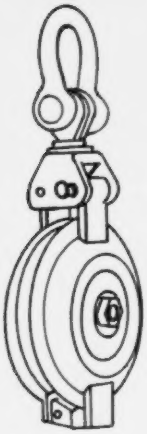
FIGURE 56



INFORMATION SHEET

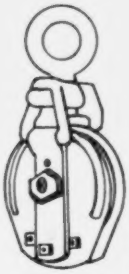
C. Swivel shackle

FIGURE 57



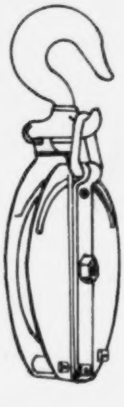
D. Swivel eye

FIGURE 58



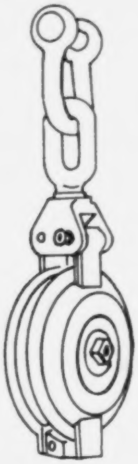
E. Drop link

FIGURE 59



F. Upset swivel shackle

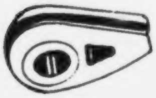
FIGURE 60



XIX. Types of cable fittings (Figures 61-85)

A. Standard solid thimble

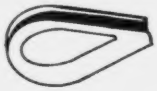
FIGURE 61



INFORMATION SHEET

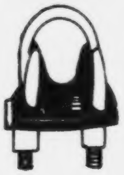
B. Standard hawser thimble

FIGURE 62



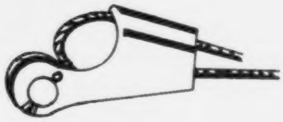
C. Drop-forged clip

FIGURE 63



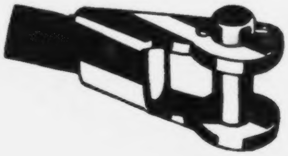
D. Open-wedge socket

FIGURE 64



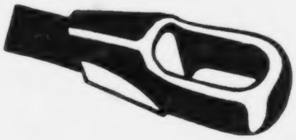
E. Open-socket for flat rope

FIGURE 65



F. Closed-socket for flat rope

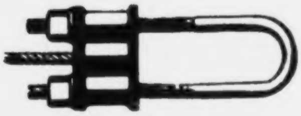
FIGURE 66



INFORMATION SHEET

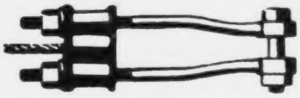
G. Closed-type bridge socket

FIGURE 67



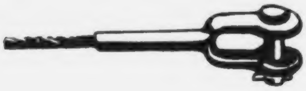
H. Open-type bridge socket

FIGURE 68



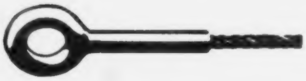
I. Swaged clevis fitting

FIGURE 69



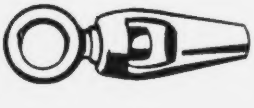
J. Swaged round eye fitting

FIGURE 70



K. Swivel eye and socket

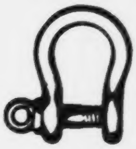
FIGURE 71



INFORMATION SHEET

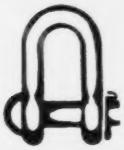
L. Screw pin shackle

FIGURE 72



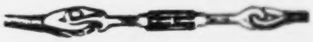
M. Standard shackle

FIGURE 73



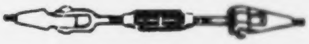
N. Turnbuckle with spliced rope

FIGURE 74



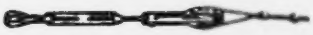
O. Turnbuckle with socketed rope

FIGURE 75



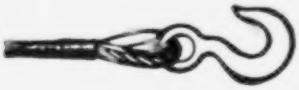
P. Turnbuckle with clipped rope

FIGURE 76



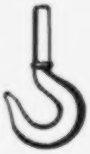
Q. Drop-forged steel hook with thimble

FIGURE 77



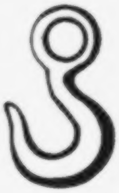
R. Drop-forged steel hook with shank

FIGURE 78



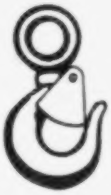
S. Drop-forged steel hook with eye

FIGURE 79



T. Safety snap hook

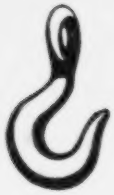
FIGURE 80



INFORMATION SHEET

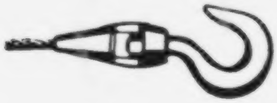
U. Reversed eye hook

FIGURE 81



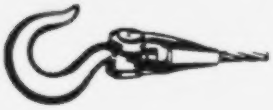
V. Drop-forged steel swivel hook and socket

FIGURE 82



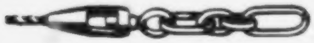
W. Logging swivel hook and socket with double swivel

FIGURE 83



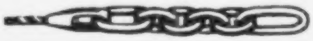
X. Swivel eye socket with chain

FIGURE 84



Y. Closed socket with chain

FIGURE 85



INFORMATION SHEET

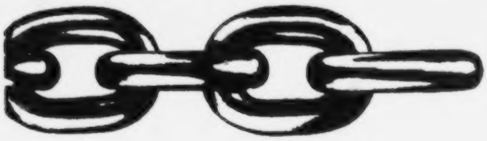
XX. Types of towing chain and accessories (Figures 86-95)

A. Chains

(NOTE: Chain is made in a variety of sizes, strengths, and designs; size is designated by diameter of bar used to make links and ranges in size from 1/4" to 2".)

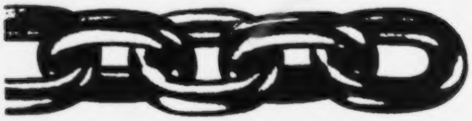
1. Proof chain

FIGURE 86



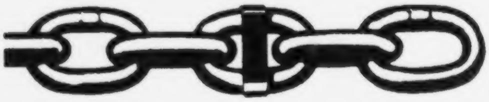
2. BBB chain

FIGURE 87



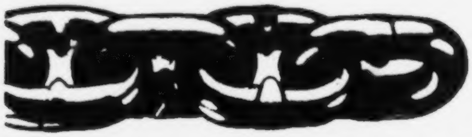
3. High test chain

FIGURE 88



4. Alloy chain

FIGURE 89

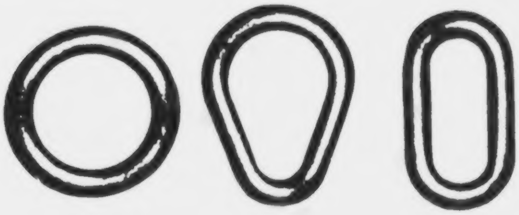


INFORMATION SHEET

B. Accessories

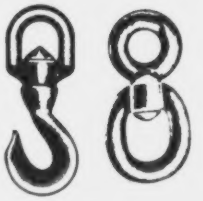
1. Rings

FIGURE 90



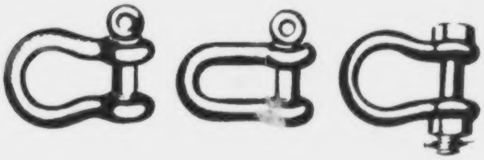
2. Swivels

FIGURE 91



3. Shackles

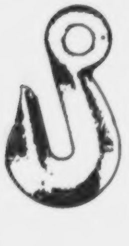
FIGURE 92



4. Hooks

a. Grab hook

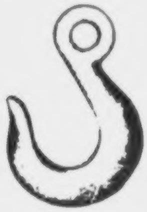
FIGURE 93



INFORMATION SHEET

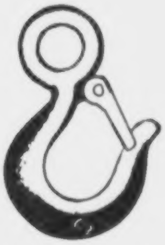
b. Slip hook

FIGURE 94



c. Safety hook

FIGURE 95



XXI. Good rigging practices

A. Turn hooks out

B. Use shackles on chokers where there may be cutting action

C. Pad all sharp corners and edges

D. Always make vertical lifts on eye bolts

(NOTE: Lifting at an angle reduces safe load as much as ninety percent.)

E. Use thimbles in eye splices

F. Use a shackle whenever two or more ropes are to be used over a hook

G. Use tagline to control loads

H. Secure all unused sling lines

I. Never wrap a rope around a hook

J. Do not permit bending of rope near a splice or attached fitting

K. Block all loads properly before unhooking

INFORMATION SHEET

L. Never allow a shackle to be pulled at an angle

(NOTE: Use washers for packing if necessary.)

M. Do not use screw pin shackle if the pin can roll under load and unscrew

N. Center crane over load before lifting

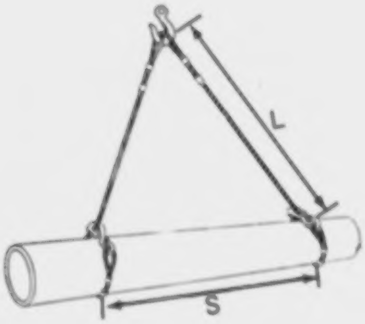
O. Give all hand signals clearly and correctly

P. Keep machines at least ten feet (10') from all electrical equipment

Q. For proper sling angle, be sure length of slings is always greater than the span between the two connections (Figure 96)

EXAMPLE: L (length of sling) is greater than S (span)

FIGURE 96



RIGGING
UNIT I

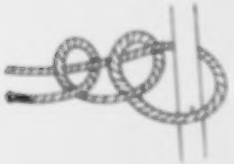
ASSIGNMENT SHEET #1 — DISTINGUISH AMONG TYPES OF KNOTS

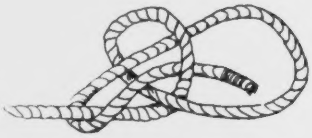
NAME ______________________________ SCORE ______________

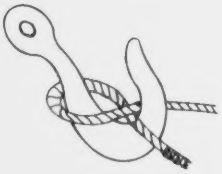
The movement and hoisting of heavy equipment and materials in the commercial carpentry trade require that carpenters be familiar with rigging procedures including how to tie a good knot. A good knot should be easy to tie, should hold without slipping, and should be easy to untie.

Distinguish among types of knots by writing an "X" in the blanks under the correct illustrations.

1. Bowline

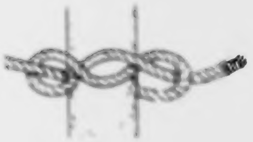


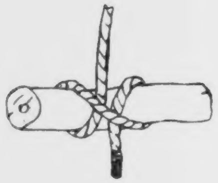


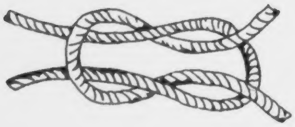


a. ______________ b. ______________ c. ______________

2. Square knot



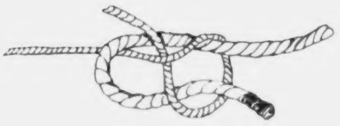


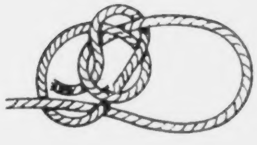


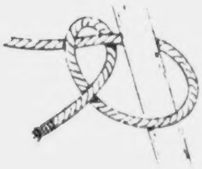
a. ______________ b. ______________ c. ______________

ASSIGNMENT SHEET #1

3. Sheet bend

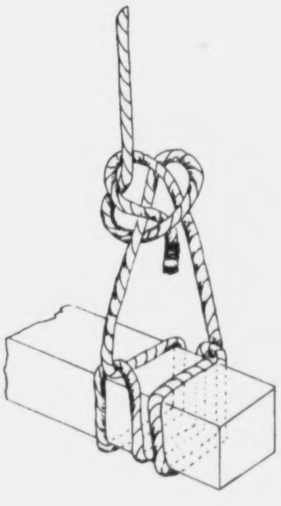


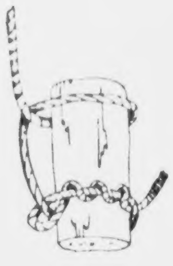


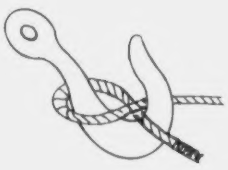


a. ____________________ b. ____________________ c. ____________________

4. Timber hitch with half hitch





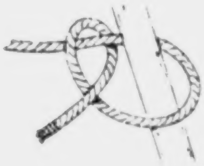


a. ____________________ b. ____________________ c. ____________________

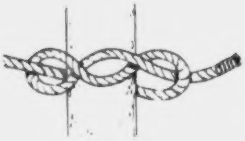
ASSIGNMENT SHEET #1

Write an "X" in the correct blanks.

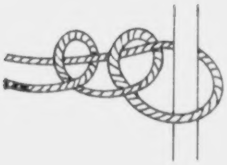
5. _____a. Timber hitch
   _____b. Black wall hitch
   _____c. Half hitch



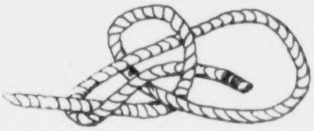
6. _____a. Clove hitch
   _____b. Timber hitch
   _____c. Square knot



7. _____a. Two half hitches
   _____b. Sheet bend
   _____c. Scaffold hitch



8. _____a. Square knot
   _____b. Bowline
   _____c. Clove hitch

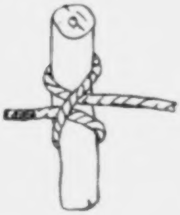


ASSIGNMENT SHEET #1

9. ______a. Timber hitch with half hitch

______b. Clove hitch

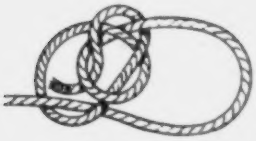
______c. Blackwell hitch



10. ______a. Bowline

______b. Half hitch

______c. Running bowline



RIGGING
UNIT I

ASSIGNMENT SHEET #2 — CALCULATE SAFE WORKING LOAD (SWL) OF DIFFERENT TYPES AND SIZES OF ROPES

NAME ______________________________ SCORE ______________

Safe rigging requires that the ropes being used are strong enough to perform the job. The strength of a rope depends on its diameter, the material from which it is made, and how it is used. The skilled carpenter knows how to calculate safe working loads (SWL) so that strong enough ropes are used without a waste of money for ropes that are too large or of more expensive materials.

Calculate the safe working load (SWL) of different types and sizes of ropes. Use the Information Sheet for reference.

Matematical constants:

20 — Manila

35 — Polyethylene

40 — Polypropylene

60 — Nylon and polyester

EXAMPLES: 1/2" manila rope = 4/8"

SWL = 4×4×20 = 320 lbs

1. 1" manila rope

   SWL = ____________

2. 1 1/2" manila rope

   SWL = ____________

3. 3/8" nylon rope

   SWL = ____________

ASSIGNMENT SHEET #2

4. 7/8" polyester rope

   SWL = ____________

5. 1/2" polypropylene rope

   SWL = ____________

6. 7/8" polypropylene rope

   SWL = ____________

7. 3/4" polypropylene rope

   SWL = ____________

8. 5/8" manila rope

   SWL = ____________

9. 1 1/4" nylon rope

   SWL = ____________

10. 1" polyethylene rope

    SWL = ____________

RIGGING
UNIT I

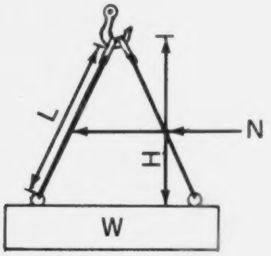
ASSIGNMENT SHEET #3 — CALCULATE SLING STRESS

NAME ____________________________ SCORE ______________

Bulky equipment and material loads require slings for proper hoisting. Slings help to distribute the weight and balance of the load. But the rigger must be careful not to create excessive stress on the sling. Therefore, a skilled commercial carpenter is able to calculate sling stress

Calculate sling stress for the following illustrations.

EXAMPLE:



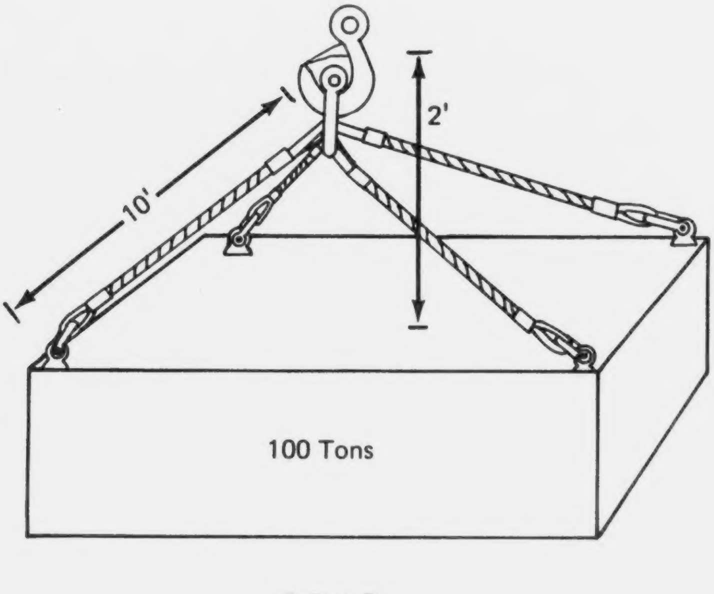
$W = 10$
$L = 3$
$H = 2$
$N = 2$

$$\frac{W \times L}{H \times N} = \text{Sling stress}$$

$$\frac{10 \times 3}{2 \times 2} = \frac{30}{4} = 7\tfrac{1}{2}$$

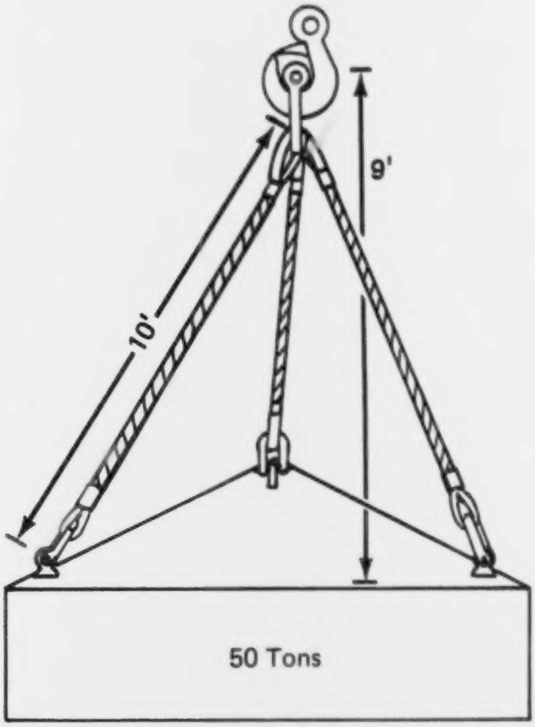
Stress = $7\tfrac{1}{2}$ tons each sling

1. Sling stress = ______________



ASSIGNMENT SHEET #3

2. Sling stress = ______________



RIGGING
UNIT I

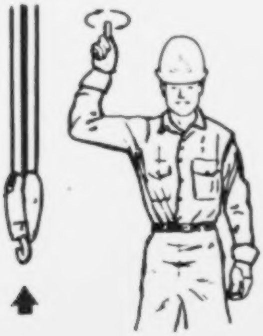
ASSIGNMENT SHEET #4 — DISTINGUISH AMONG HAND SIGNALS USED IN RIGGING OPERATIONS

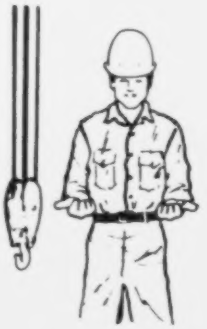
NAME ______________________________ SCORE ______________

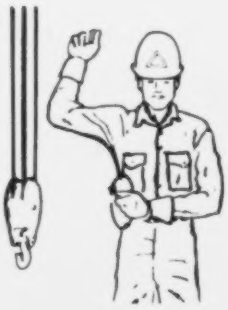
In heavy equipment operations it is very important to know how to use hand signals. By knowing them you will be able to direct operations efficiently and you may be able to help another worker get out of a bad situation and possibly avoid a serious accident.

Distinguish among hand signals by writing an "X" under the correct illustrations.

1. Hoist the load

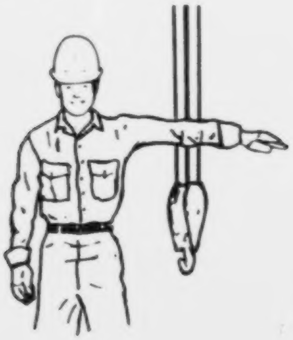


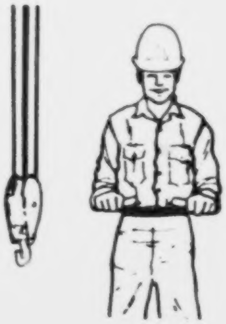


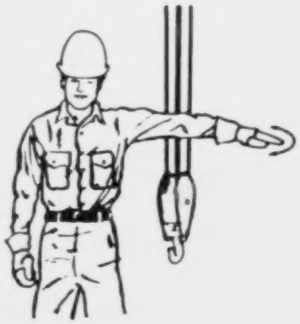


a. ______________ b. ______________ c. ______________

2. Emergency stop



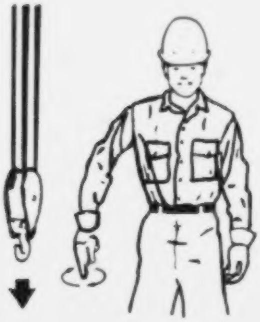


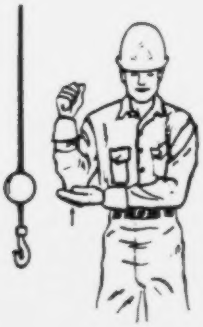


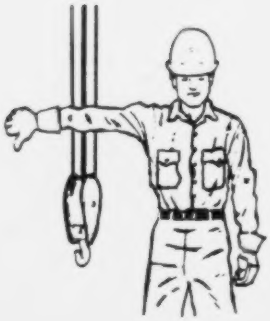
a. ______________ b. ______________ c. ______________

ASSIGNMENT SHEET #4

3. Lower the boom

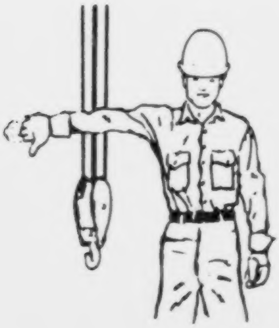


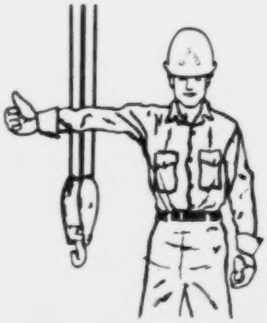


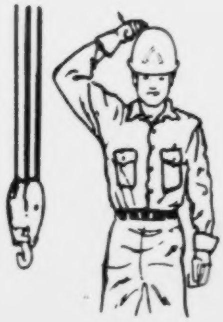


a. ____________________ b. ____________________ c. ____________________

4. Lower the boom and raise the load



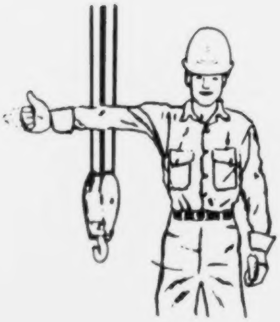


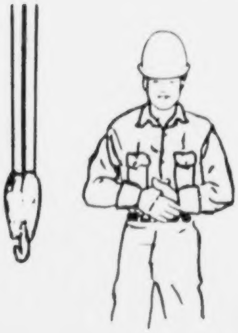


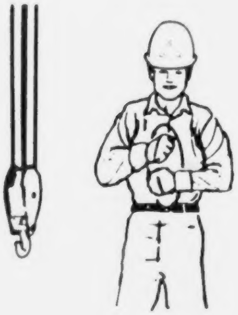
a. ____________________ b. ____________________ c. ____________________

ASSIGNMENT SHEET #4

5. Dog everything

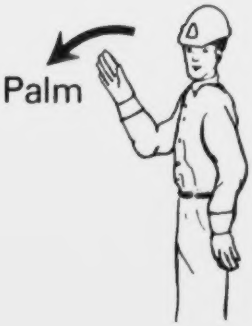


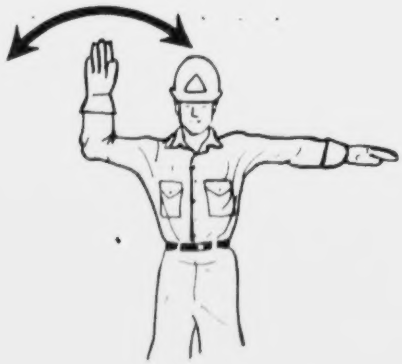


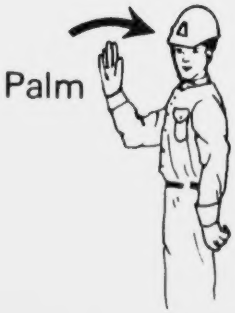


a. ____________________ b. ____________________ c. ____________________

6. Turn while moving







a. ____________________ b. ____________________ c. ____________________

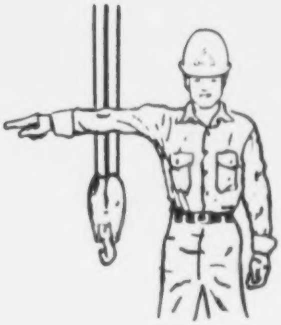
ASSIGNMENT SHEET #4

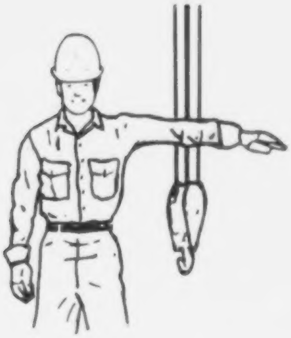
Write and "X" in the correct blanks.

7. ______a. Turn while moving

______b. Swing

______c. Move in this direction

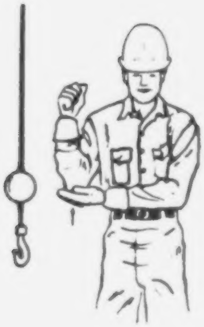




8. ______a. Move in this direction

______b. Stop

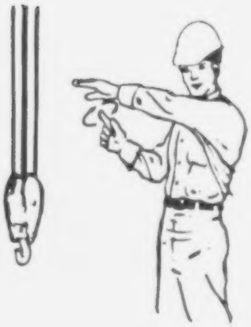
______c. Raise the boom



9. ______a. Emergency stop

______b. Rehaul or retract

______c. Use whipline



10. ______a. Lower the boom and hold the load

______b. Lower the boom and raise the load

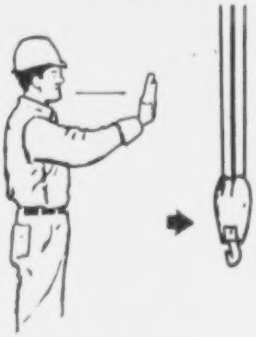
______c. Move slowly

ASSIGNMENT SHEET #4

11. ______a. Lower the load

______b. Lower the boom

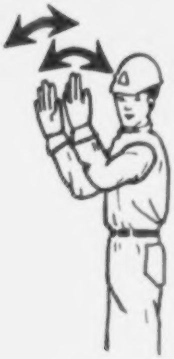
______c. Travel



12. ______a. Stop

______b. Straighten out

______c. Turn while moving



RIGGING
UNIT I

ASSIGNMENT SHEET #5— CALCULATE SAFE WORKING LOAD (SWL) OF DIFFERENT SIZES OF WIRE ROPES

NAME ______________________________ SCORE ______________

Wire ropes are used extensively in rigging operations on commercial construction jobs. For safe hoisting, the rigger must be able to calculate the safe working load (SWL) for the rope being used.

Calculate safe working load (SWL) of different sizes of wire ropes. Use the Information Sheet for reference. Round all answers to nearest whole number.

EXAMPLE: ½" diameter rope

½" × ½" × 8 = 2 tons

1. ⅝" diameter rope

   SWL = ____________

2. ⅞" diameter rope

   SWL = ____________

3. 1" diameter rope

   SWL = ____________

4. 1⅛" diameter rope

   SWL = ____________

5. 1½" diameter rope

   SWL = ____________

RIGGING
UNIT I

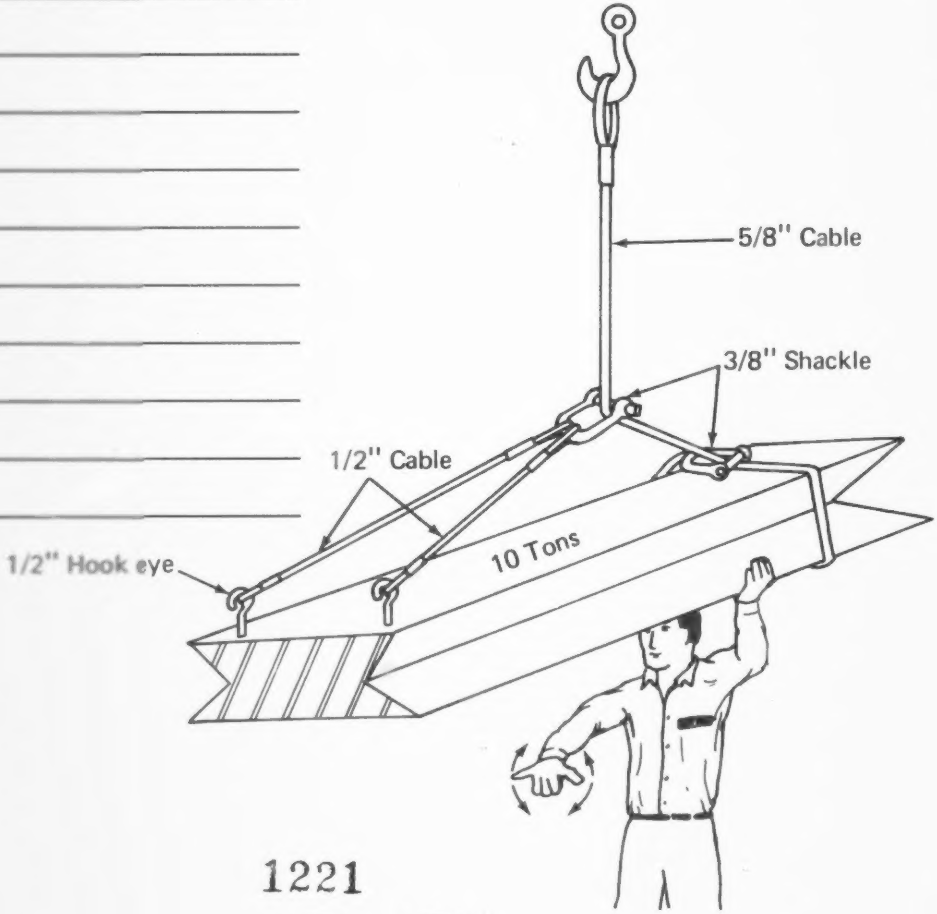
ASSIGNMENT SHEET #6— IDENTIFY POOR RIGGING PRACTICES

NAME ____ SCORE ________________

The use of safe practices in rigging operations cannot be over emphasized because of the potential damage to equipment and materials and the very real possibility of injury or even death. The skilled construction worker is always alert to unsafe practices and knowledgeable of correct procedures.

Using the illustration below, write down as many bad rigging practices as you can find. Also list any tips that are not observed in the drawing.

1. ________________________
2. ________________________
3. ________________________
4. ________________________
5. ________________________
6. ________________________
7. ________________________
8. ________________________
9. ________________________
10. ________________________
11. ________________________
12. ________________________



RIGGING
UNIT I

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #1

1. b
2. c
3. a
4. b
5. c
6. b
7. a
8. b
9. b
10. c

Assignment Sheet #2

1. 1280 lbs
2. 2880 lbs
3. 540 lbs
4. 2940 lbs
5. 640 lbs
6. 1960 lbs
7. 1440 lbs
8. 500 lbs
9. 6000 lbs
10. 2240 lbs

Assignment Sheet #3

1. 125 tons each sling
2. 18½ tons each sling

ANSWERS TO ASSIGNMENT SHEETS

Assignment Sheet #4

1. a
2. c
3. c
4. a
5. b
6. b
7. b
8. b
9. c
10. c
11. c
12. b

Assignment Sheet #5

1. 3 tons
2. 6 tons
3. 8 tons
4. 10 tons
5. 18 tons

Assignment Sheet #6

1. Incorrect hand signals
2. Operator cannot see hand signals
3. Hand is on load
4. Person is under load
5. No tagline
6. Load is not balanced
7. No padding on sharp edges
8. No safety latch on hook block
9. Hook eyes too small and not in far enough

ANSWERS TO ASSIGNMENT SHEETS

10. Sling angle too small
11. All sling cables too small
12. Shackles too small

RIGGING
UNIT I

JOB SHEET #1 — TIE KNOTS

I. Materials

A. Two pieces of equal-sized rope

B. One piece of different-sized rope

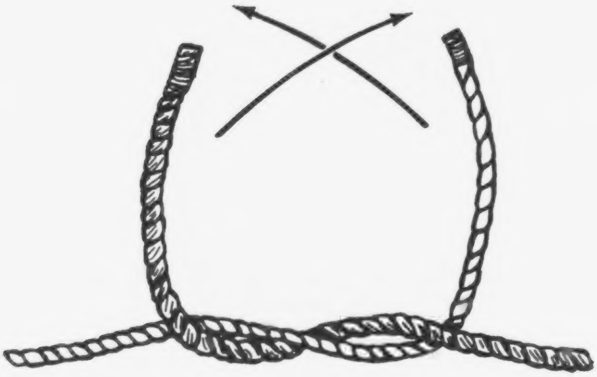
C. One piece of timber or pole

II. Procedure

(NOTE: When tying a square knot it is good to remember left-over-right and right-over-left.)

1. Use two pieces of equal-sized rope
2. Grasp one piece of rope in each hand about eight inches from end
3. Cross left end over right end (Figure 96)

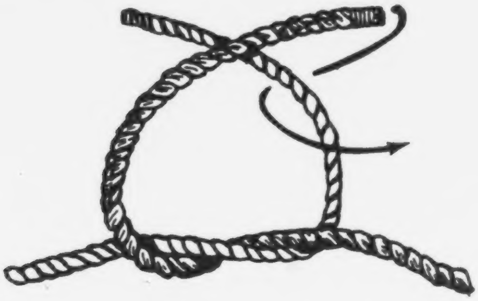
FIGURE 96



JOB SHEET #1

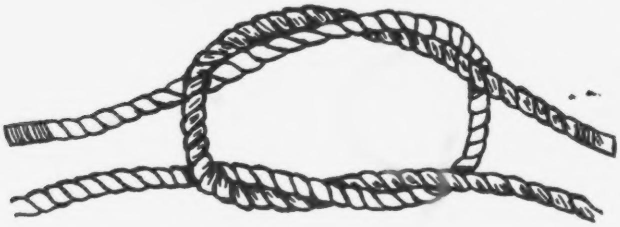
4. Cross right end over left end (Figure 97)

FIGURE 97



5. Pull the knot snug (Figure 98)

FIGURE 98

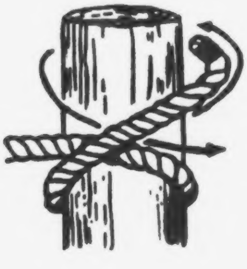


B. Clove hitch

1. Grasp one piece of rope and make one turn around a piece of timber

2. Cross the end over the standing part (Figure 99)

FIGURE 99

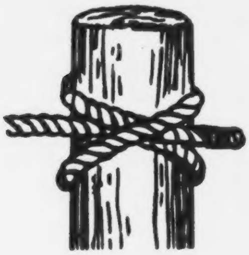


JOB SHEET #1

3. Take another turn around timber, and this time bring the end under the standing part

4. Pull the knot snug (Figure 100)

FIGURE 100

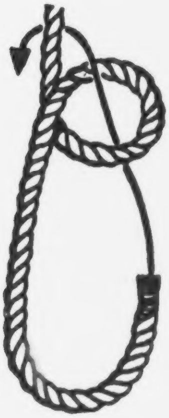


C. Bowline

1. Form an underhand loop several inches from end of rope

2. Pull rope end up through the loop from the back, leaving desired loop size (Figure 101)

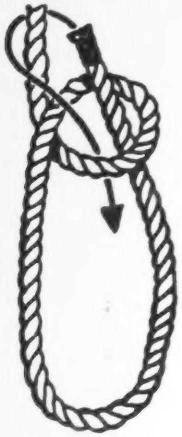
FIGURE 101



JOB SHEET #1

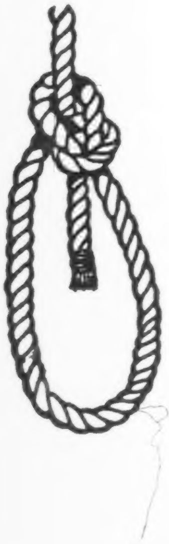
3. Twist rope end around the standing part and back through the loop (Figure 102)

FIGURE 102



4. Pull the knot snug (Figure 103)

FIGURE 103

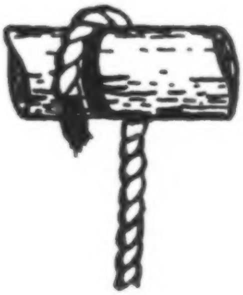


JOB SHEET #1

D. Half hitch

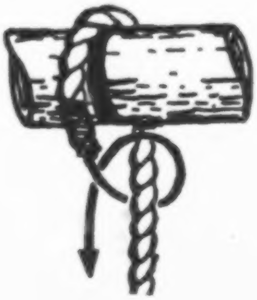
1. Make a turn over a piece of timber (Figure 104)

FIGURE 104



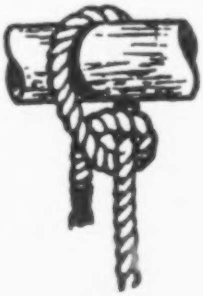
2. Make a turn around and over the standing part and back through the loop that was formed (Figure 105)

FIGURE 105



3. Pull knot snug (Figure 106)

FIGURE 106

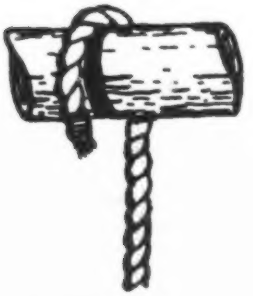


JOB SHEET #1

E. Two half hitches

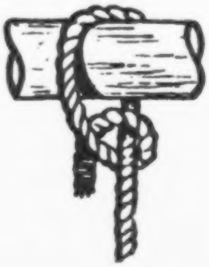
1. Make a turn over a piece of timber (Figure 107)

FIGURE 107



2. Make a turn around and over the standing part and back through the loop that was formed (Figure 108)

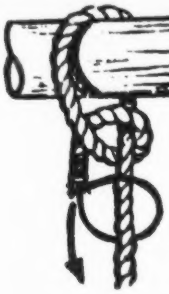
FIGURE 108



JOB SHEET #1

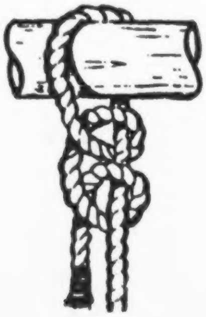
3. Make another turn around the standing part and back through the loop that formed (Figure 109)

FIGURE 109



4. Pull knot snug (Figure 110)

FIGURE 110

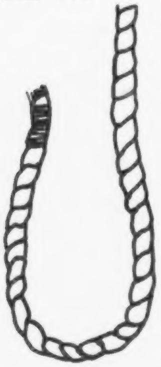


(NOTE: If the two hitches are slid together along the standing part to form a single knot, the knot becomes a clove hitch.)

F. Sheet bend

1. Form a loop on the end of one rope (Figure 111)

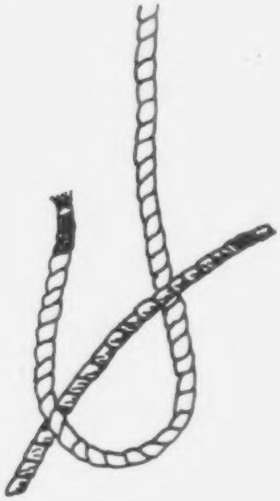
FIGURE 111



JOB SHEET #1

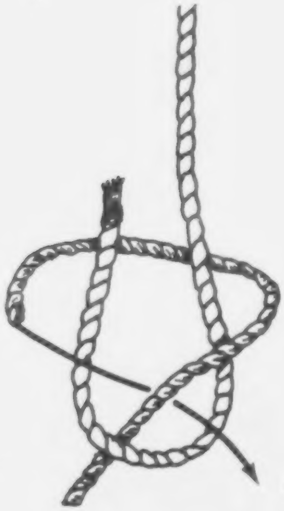
2. Lay second rope through the loop (Figure 112)

FIGURE 112



3. Twist end of second rope around standing part and running end of first rope (Figure 113)

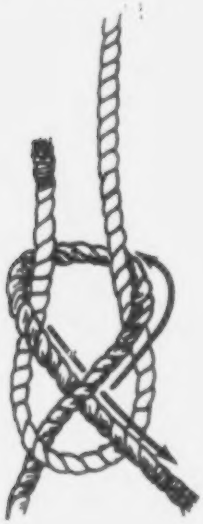
FIGURE 113



JOB SHEET #1

4. Continue bringing second rope around first rope; then run the end under standing part of itself and over first rope (Figure 114)

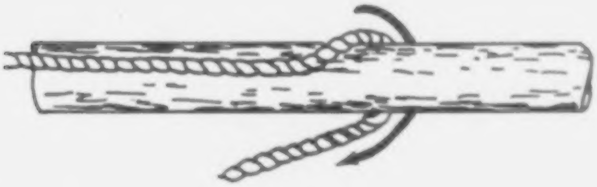
FIGURE 114



G. Timber hitch with half hitch

1. Lay rope lengthwise on timber; then make a turn over and around the piece of timber (Figure 115)

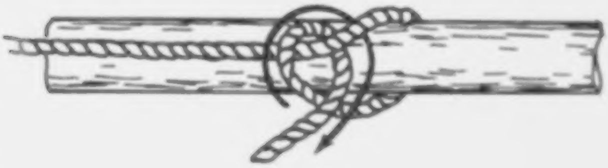
FIGURE 115



JOB SHEET #1

2. Place rope over and then under itself forming loop (Figure 116)

FIGURE 116



3. Wrap end back around itself two or three times (Figures 117 and 118)

FIGURE 117

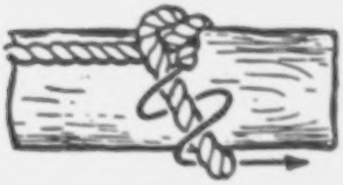
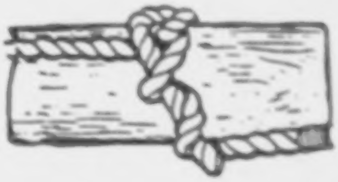


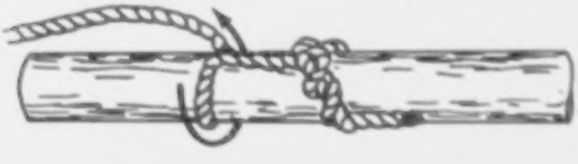
FIGURE 118



4. Pull rope so that it is snug

5. Pick up rope from timber, and make a loop under and around timber several inches from timber hitch (Figure 119)

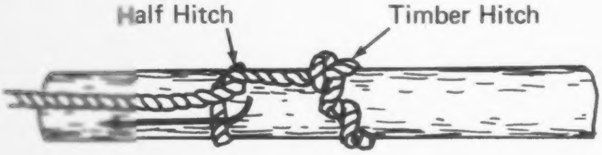
FIGURE 119



JOB SHEET #1

6. Loop rope under itself, and then pull snug (Figure 120)

FIGURE 120


Half Hitch
Timber Hitch

RIGGING
UNIT I

JOB SHEET #2 — INSTALL WIRE ROPE CLIPS

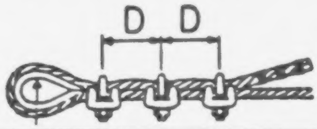
I. Tools and equipment

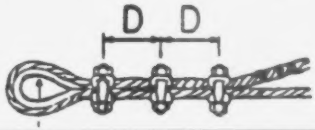
- A. Length of wire rope
- B. Clips, 3
- C. Thimble
- D. Wrench (to fit nuts on clips)
- E. Torque wrench

II. Procedure

- A. Determine number of clips and spacing required from Table 2

TABLE 2 — Clip and Spacing Requirements for 80 Percent of Strength



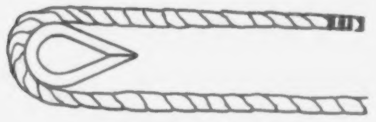


	U-BOLT CLIP		FIST GRIP CLIP	
Diameter of Wire Rope Inches	Number of Clips for Improved Plow Steel	Minimum Spacing (D) Between Clips Inches	Number of Clips for Improved Plow Steel	Minimum Spacing (D) Between Clips Inches
3/8	3	3 1/4	3	3 1/4
1/2	4	3 3/4	3	3 3/4
5/8	4	4	3	4
3/4	5	4 1/2	4	4 1/2
7/8	5	5 1/4	4	5 1/4
1	5	6	5	6
1 1/8	5	6 3/4	5	6 3/4
1 1/4	6	7 1/2	6	7 1/2
1 3/8	7	8 1/4	6	8 1/4
1 1/2	7	9	6	9

JOB SHEET #2

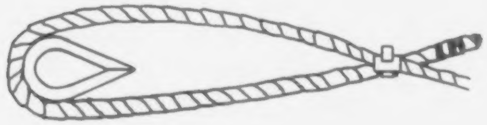
B. Turn back length of rope beyond pointed end of thimble equal to the number of clips times the clip spacing (Figures 121)

FIGURE 121



C. Position first clip at least one clip base width from end of wire rope (Figure 122)

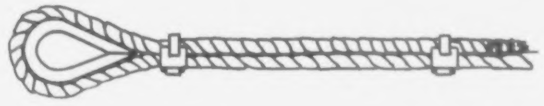
FIGURE 122



D. Tighten nuts, alternating from one side to the other to obtain equal clamping action

E. Position second clip next to end of thimble and tighten nuts until firm but not tight (Figure 123)

FIGURE 123

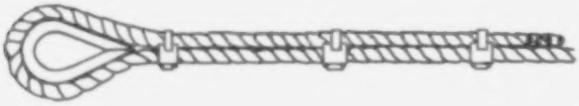


F. Space the other clips at correct positions and tighten nuts until firm

JOB SHEET #2

G. Take up any rope slack; then alternately tighten nuts on each clip until they are tight (Figure 124)

FIGURE 124



H. Torque to manufacturer's specifications

RIGGING
UNIT I

JOB SHEET #3 — RIG AND HANDLE TYPES OF LOADS

I. Equipment

- A. Hoist
- B. Load
- C. Slings
- D. Spreader bar

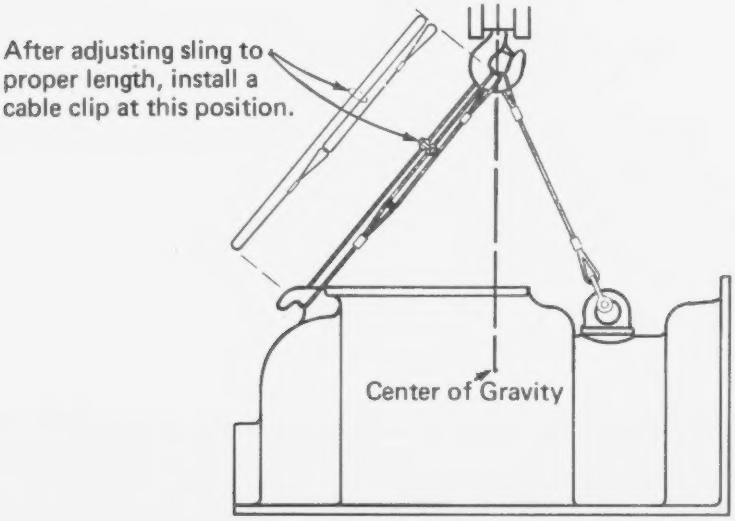
II. Procedure for load where center of gravity is non-centered

CAUTION

For loads that appear to be extremely heavy, the exact weight of load must be determined prior to rigging to assure that load will not exceed lifting capacity of hoist or exceed safe working load of wire rope used.)

- A. Estimate location of center of gravity
- B. Spot hook over this point
- C. Attach slings of proper strength and length from hook to lifting lugs (Figure 125)

FIGURE 125


After adjusting sling to proper length, install a cable clip at this position.
Center of Gravity

Used with permission of McGraw-Hill Book Company

(NOTE: Slings of different lengths will probably have to be used. Because they are not always available, it may be necessary to improvise.)

JOB SHEET #3

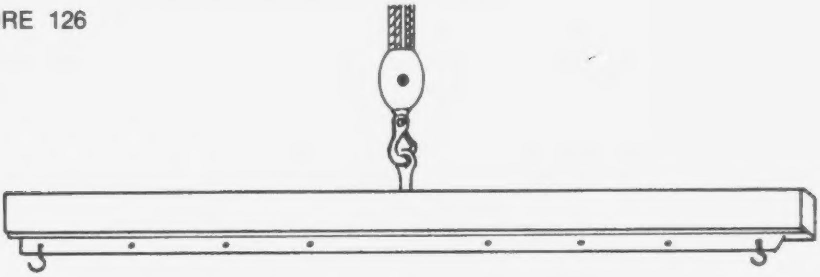
CAUTION

Be very careful that proper slings are used and that they are attached properly. Use wire rope clips if necessary.)

III. Procedure for rigging extra long loads

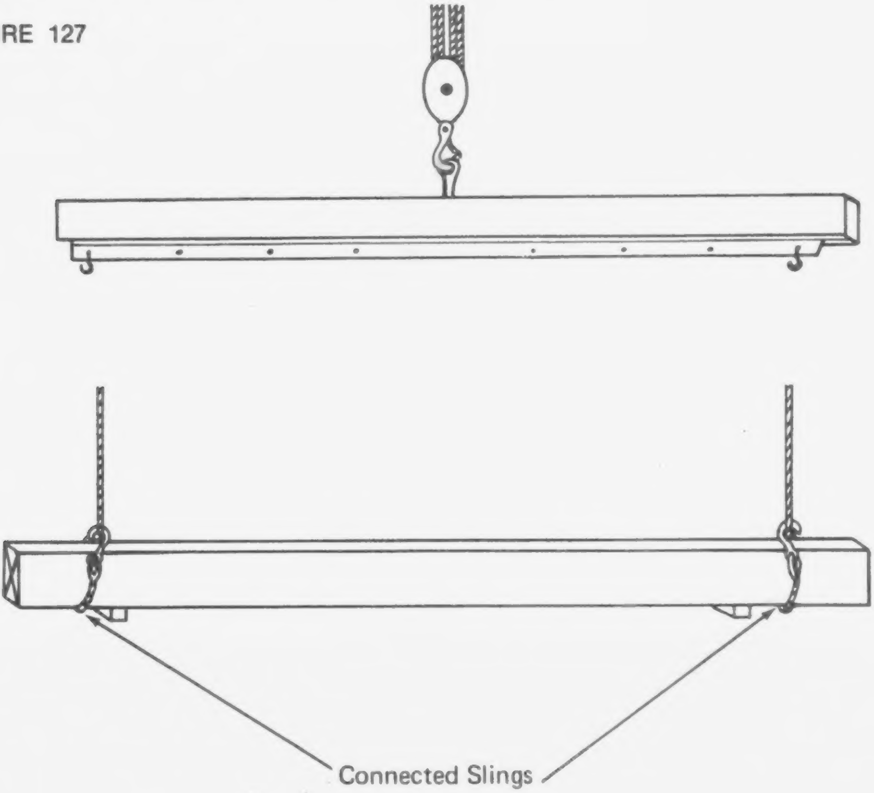
A. Attach spreader bar to hoist hook (Figure 126)

FIGURE 126



B. Center spreader bar over load; then connect sling to each end of load (Figure 127)

FIGURE 127

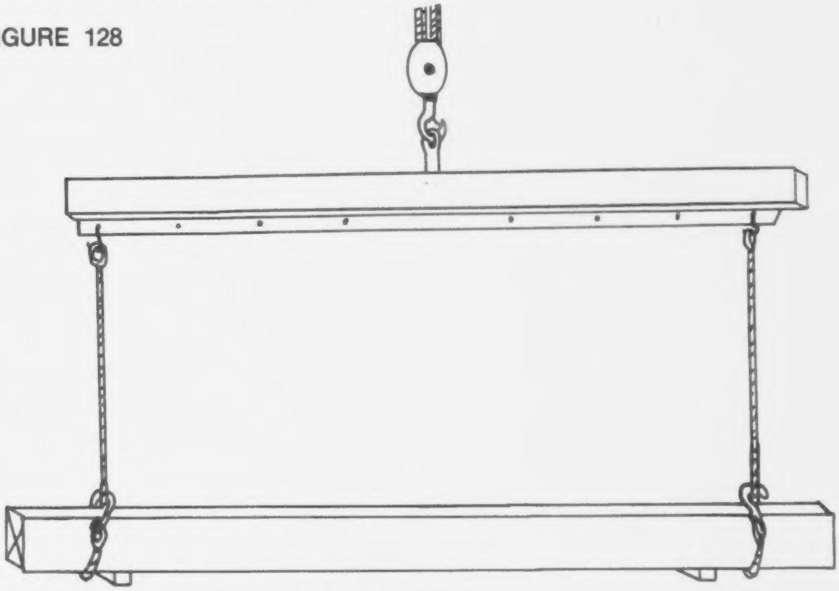


JOB SHEET #3

C. Connect long end of slings to spreader bar (Figure 128)

(NOTE: Be sure that hooks face out.)

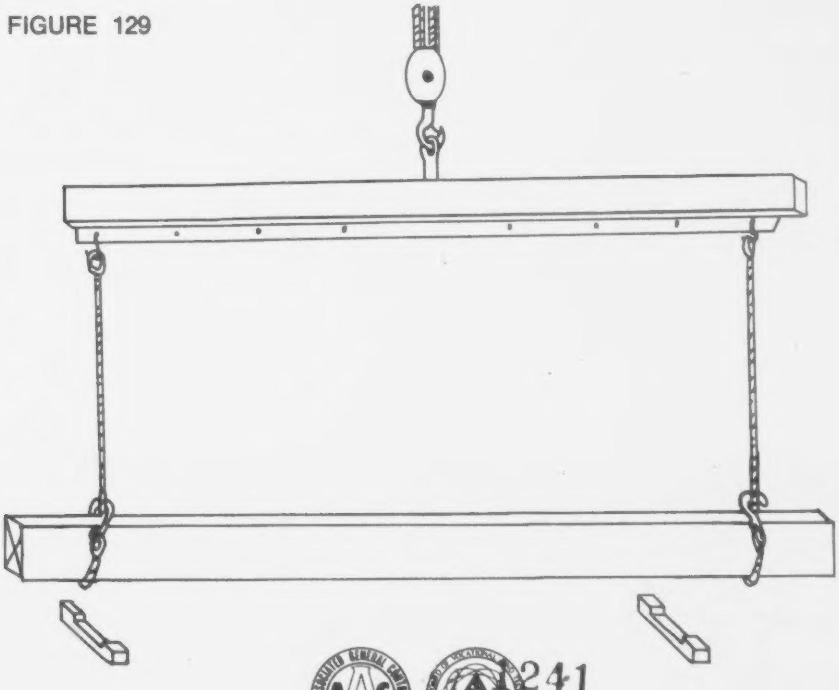
FIGURE 128



D. Give signal to hoist load slowly

E. Take up strain on line by lifting just a few inches off ground to check balance of load (Figure 129)

FIGURE 129



JOB SHEET #3

F. Give signal to stop

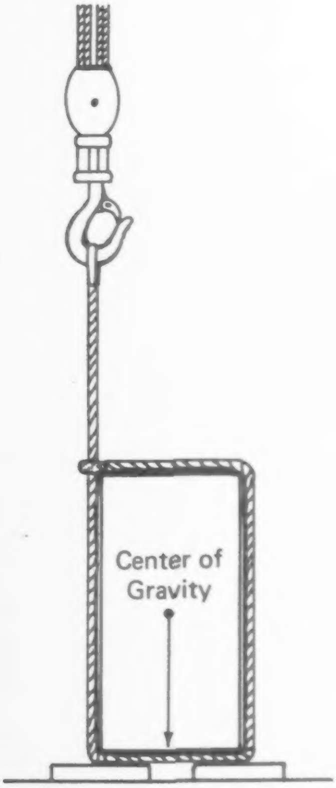
G. Give signal to lower load

IV. Procedure for turning or rotating a load

A. Attach single sling so that the part of sling leading from hoist hook will go directly to bottom of load (Figure 130)

(NOTE: Be sure hook points away from hoist.)

FIGURE 130



B. Attach sling to hook

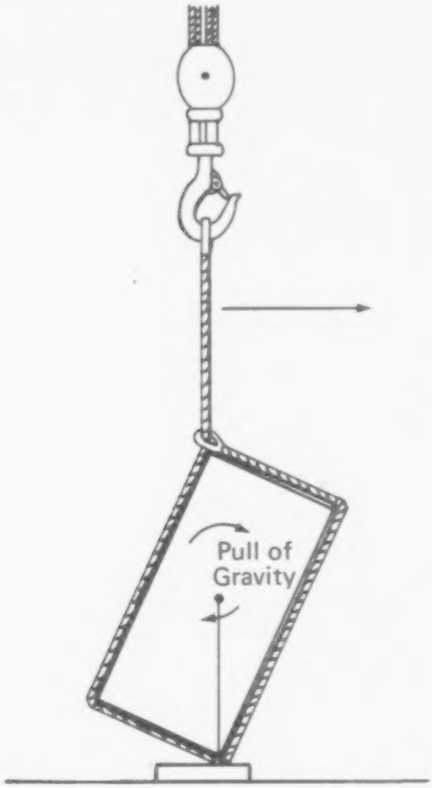
C. Give hand signal to hoist load and move boom so hook will move forward

JOB SHEET #3

D. When load is just clear of surface, give signal to stop hoisting

(NOTE: This will cause load to tilt. See Figure 131.)

FIGURE 131



E. Give signal to move hook forward

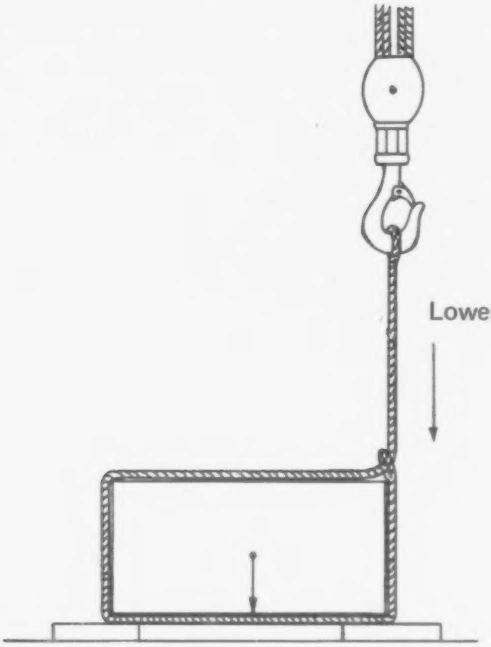
F. Give signal to stop movement when load is in position

G. Give signal to lower the hook and move forward slowly

(NOTE: This will allow the load to slowly rotate to a flat position. See Figure 132.)

JOB SHEET #3

FIGURE 132



CC - 115-D

RIGGING
UNIT I

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with rigging to the correct definitions. Write the correct numbers in the blanks provided.

______a. Setting up block and tackle to a winch, stacking and hoisting material and equipment, or replacing cables on equipment

______b. To attach a rope to a post, pole, ring, hook, or other object

______c. Rope used to guide or steady load while being lifted

______d. Pull from underneath the load

______e. Pounds per square inch

______f. Assembly of blocks and lines used to gain a mechanical advantage in lifting

______g. Grooved wheel or pulley

______h. Preliminary shaping of wire so that they will lie in place

______i. Direction, length, or angle of twist of the strands in a rope or cable

______j. Pulley in a case which can easily fasten to lines or objects by means of a hook, ring, or shackle

______k. Material used in the center of wire rope

______l. Devices used to prevent crushing of load and to lift extra long and heavy loads

______m. Point at which entire weight may be considered as concentrated

______n. Metal loop which engages a hook

______o. Grooved metal ring inserted in loop in rope to prevent wear

______p. Slang meaning to deliberately slow down

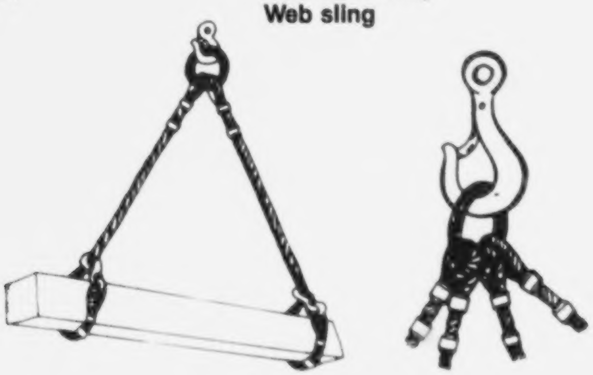
______q. To join two sections of rope or cable together to form a continuous length

1. Lay
2. Eye
3. Sheave
4. Rigging
5. Thimble
6. Snatch block
7. psi
8. Preforming
9. Tagline
10. Dog
11. Tackle
12. Heave
13. Splice
14. Core
15. Hitch
16. Center of gravity
17. Spreaders

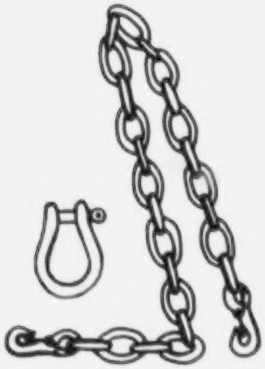
TEST

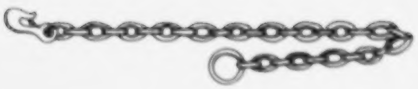
2. Identify the following accessories used for load lifting. Write the correct names in the blanks provided.

Bull chain
Bridles
Chokers (single slings)
Chain and shackle
Spreader bars
Grommet sling
Web sling



a. ______________________________

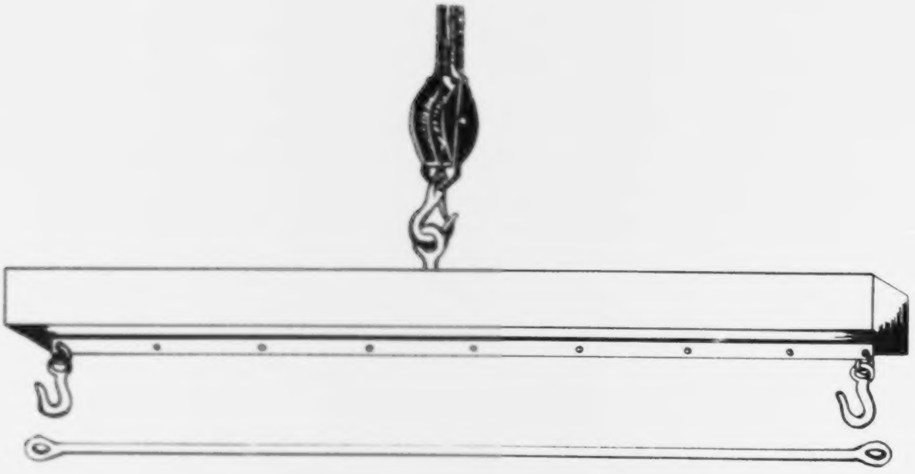




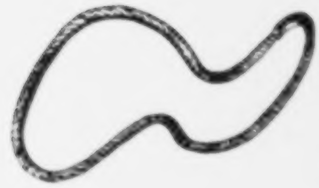
b. ______________________________

c. ______________________________

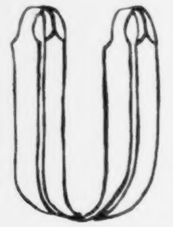
TEST



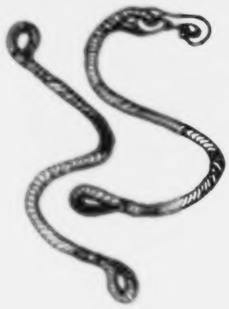
d. ______________________________



e. ______________________________



f. ______________________________

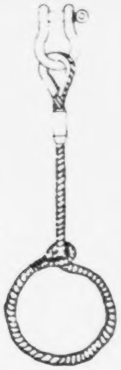


g. ______________________________

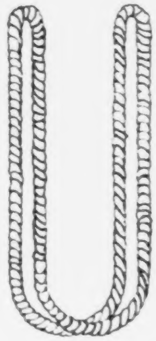
TEST

3. Identify the following hitches used for attaching materials and equipment to the hoist. Write the correct names in the blanks provided.

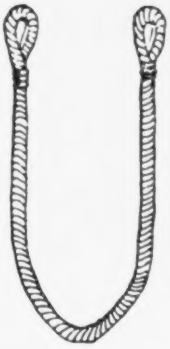
Choker hitch sling
Basket hitch sling
Choker hitch choker
Baket hitch choker
Inverted basket hitch sling



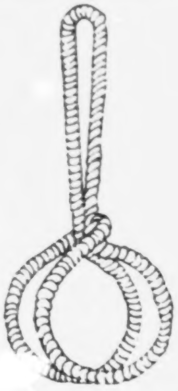
a. ______________________________



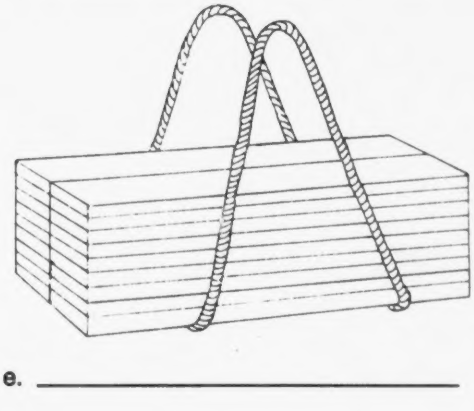
b. ______________________________



c. ______________________________



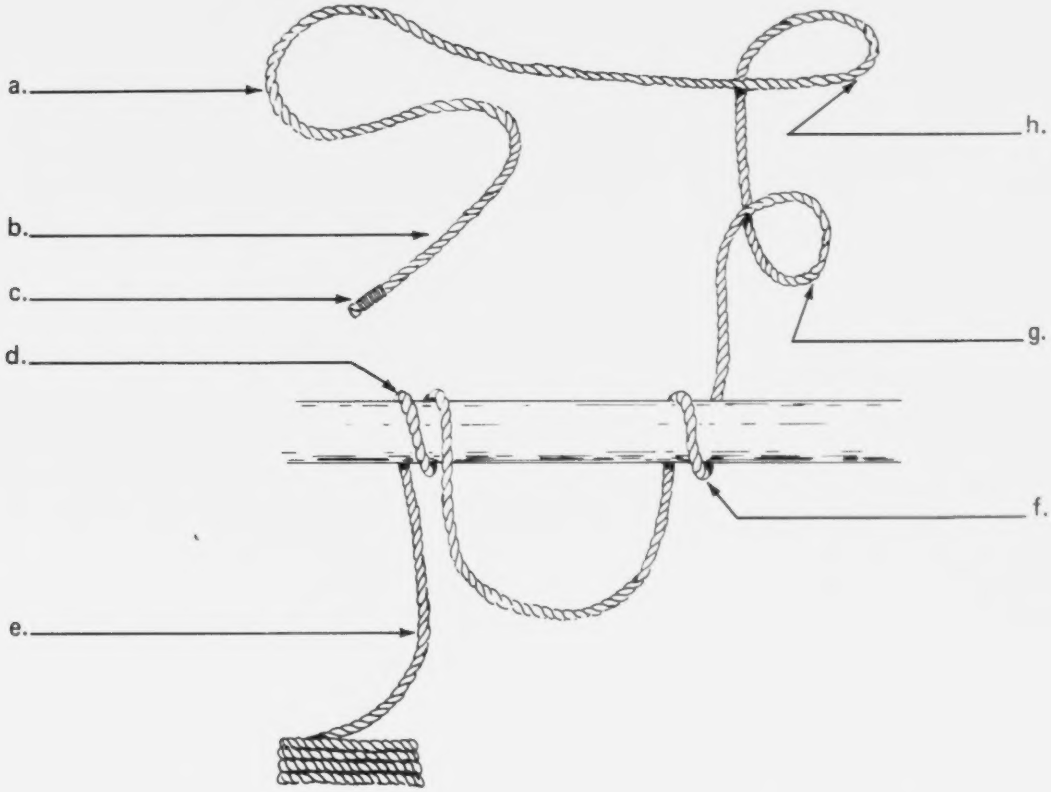
d. ______________________________



e. ______________________________

TEST

4. Label elements of knots, bends, and hitches. Write the correct names in the blanks.



5. Match types of knots to their correct uses. Write the correct numbers in the blanks provided.

_____a. Tie two knots of equal size together so that they will not slip

_____b. Forms a single loop that will not tighten or slip under strain

_____c. Fastens a line to timber or pipe

_____d. Ties line to timber or to a larger line

_____e. Holds timber securely when moving heavy timber or poles

1. Half hitch
2. Bowline
3. Clove hitch
4. Square knot
5. Blackwall hitch
6. Timber hitch

TEST

_____f. Fastens a line to a hook; generally used temporarily

_____g. Forms a strong running loop which is convenient for running an eye; can also provide a choker-type sling at the end of a line

_____h. Ties two lines of unequal size together; also used to tie a line to an eye

_____i. Holds heavy timbers or poles for lifting or dragging

_____j. Support ends of scaffold plank and prevents it from tilting

_____k. Secures the running end of a line to the standing part

7. Timber hitch with half hitch
8. Running bowline
9. Scaffold hitch
10. Two half hitches
11. Sheet bend

6. State five safety tips related to rigging.

a. ____

b. ____

c. ____

d. ____

e. ____

7. Match types of materials used in construction of ropes to their characteristics. Write the correct numbers in the blanks provided.

_____a. Strong and durable; used where dependability, ability to stand up under severe use, and resistance to weathering are required

_____b. Low durability and strength; low cost

_____c. Very strong, high abrasion resistance, good resistance to weathering, and high degree of stretch

_____d. Less strength than nylon; little stretch

1. Polypropylene
2. Nylon
3. Manila
4. Polyester
5. Polyethylene
6. Sisal

TEST

______e. Slightly less strength than nylon; little stretch; very light, actually floats on water and is resistant to rot

______f. Less strength than nylon; high stretch; excellent resistance to mildew, decay, acids, and alkalies

8. Explain general construction of rope.

9. State six precautions to observe when caring for ropes.

a. ______

b. ______

c. ______

d. ______

e. ______

f. ______

10. Calculate safe working load (SWL) of the following different types and size of ropes.

a. 3/4" manila rope

(Mathematical constant is 20.)

SWL = ______

TEST

b. 3/4" nylon rope

(Mathematical constant is 60.)

SWL = ____________

c. 3/8" polyester rope

(Mathematical constant is 60.)

SWL = ____________

d. 3/8" polyethylene rope

(Mathematical constant is 35.)

SWL = ____________

e. 1 1/8" polypropylene rope

(Mathematical constant is 40.)

SWL = ____________

11. State the importance of spreading angles in slings.

a. ____

____

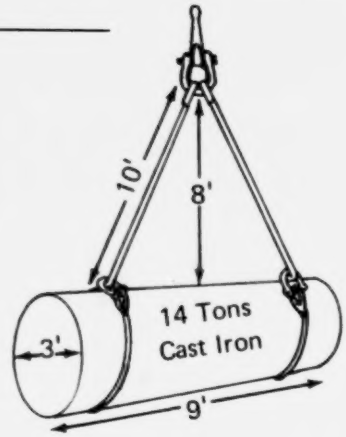
b. ____

____

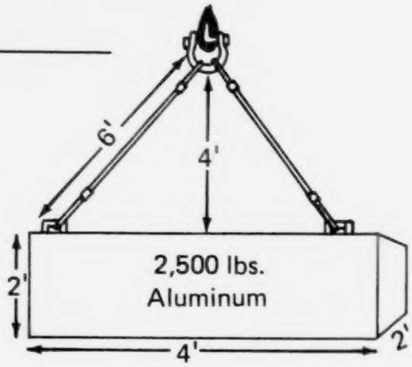
TEST

12. Calculate sling stress using the following illustrations.

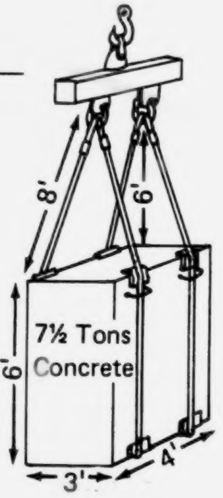
a. Stress = ________________


10'
8'
14 Tons
Cast Iron
3'
9'

b. Stress = ________________


6'
4'
2,500 lbs.
Aluminum
2'
4'
2'

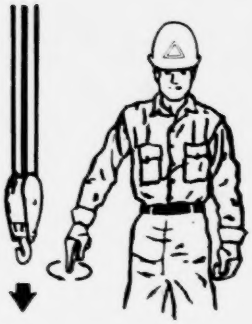
c. Stress = ________________

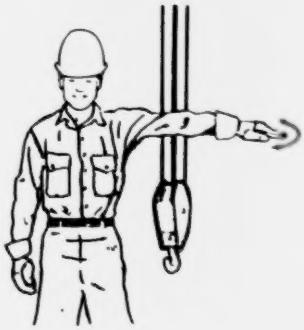

8'
6'
7½ Tons
Concrete
6'
3'
4'

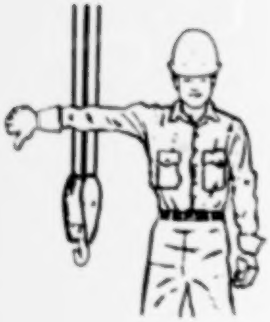
TEST

13. Distinguish among hand signals used in rigging operations. Write an "X" in the blank under each correct illustration.

a. Lower the boom

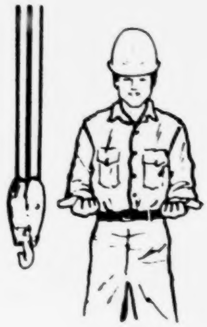


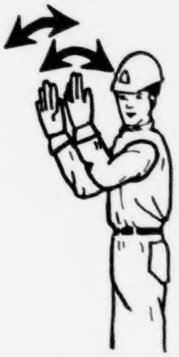


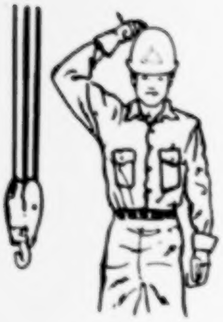


1) ____________________ 2) ____________________ 3) ____________________

b. Straighten out



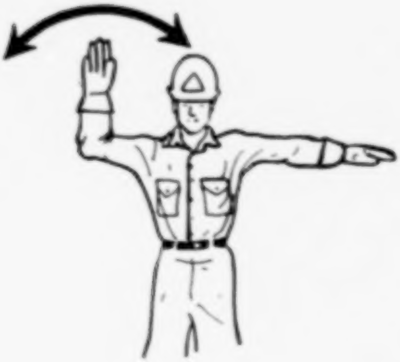


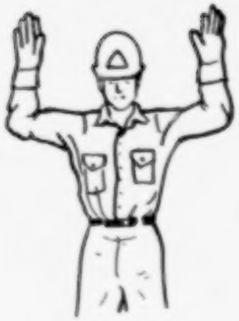


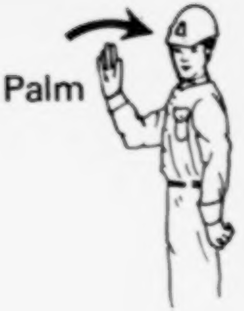
1) ____________________ 2) ____________________ 3) ____________________

TEST

c. Move backwards

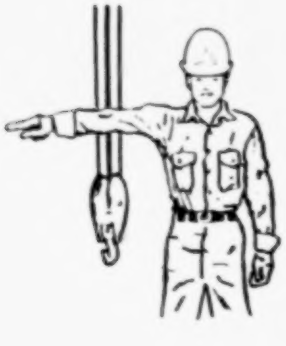


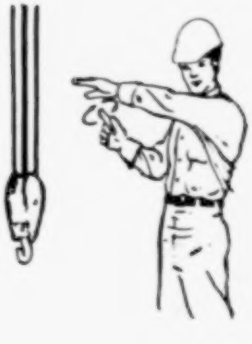


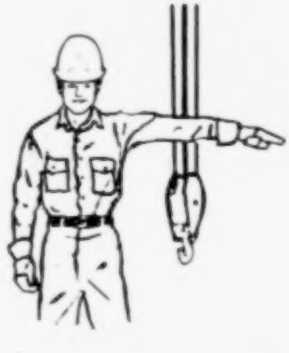


1) ______________ 2) ______________ 3) ______________

d. Swing



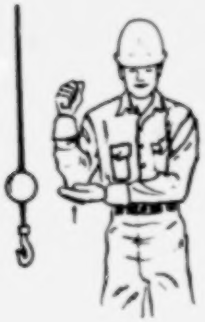


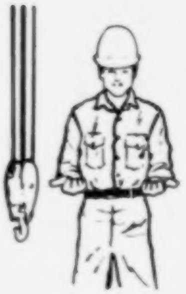


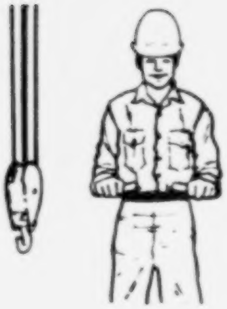
1) ______________ 2) ______________ 3) ______________

TEST

e. Retract boom

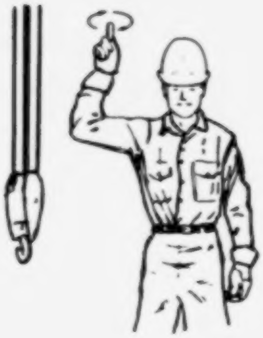


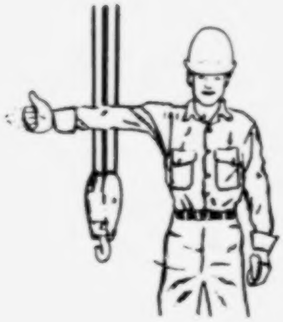


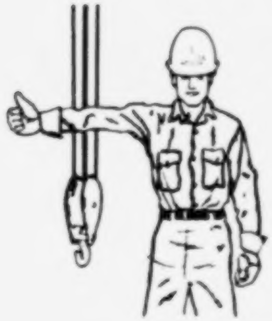


1) ______________________ 2) ______________________ 3) ______________________

f. Raise the boom and lower the load







1) ______________________ 2) ______________________ 3) ______________________

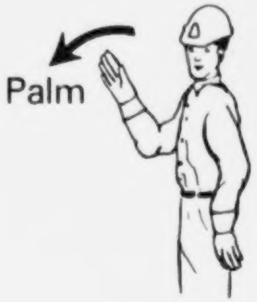
TEST

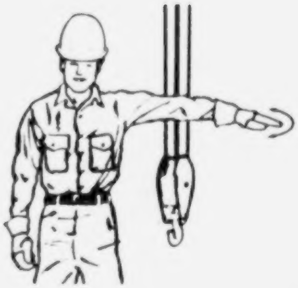
Write an "X" in the correct blanks.

g. ______1) Swing in direction finger points

______2) Move in this direction

______3) Turn while moving





h. ______1) Stop

______2) Dog

______3) Emergency stop

14. Select from the following list construction characteristics of wire rope that affect strength. Write an "X" in the correct blanks.

______a. Where rope lies

______b. Grade of steel wire used

______c. Number of turns around drum

______d. Preformed lay

______e. Size of wire in strand

______f. Number of wires in each strand

______g. Type of core

______h. Length of cable

______i. Name of cable

______j. Size of cable

TEST

15. Match strengths of steel used in wire rope to their grades. Write the correct numbers in the blanks provided.

______a. Mild plow steel

______b. Improved plow steel

______c. Iron wire

______d. Traction steel

______e. Plow steel

______f. Special improved steel

1. 200,000 to 220,000 psi
2. 240,000 to 260,000 psi
3. 180,000 to 190,000 psi
4. 100,000 psi
5. 220,000 to 240,000 psi
6. 260,000 to 280,000 psi

16. Calculate safe working load (SWL) of the following different sizes of wire ropes.

a. 3/8" diameter rope

SWL = ____________

b. 3/4" diameter rope

SWL = ____________

c. 1" diameter rope

SWL = ____________

d. 1 1/4" diameter rope

SWL = ____________

e. 1 3/8" diameter rope

SWL = ____________

17. Arrange in order steps to take when performing maintenance on wire rope. Place in the blanks provided a "1" before the first step, a "2" before the second step, and so on.

______a. Apply oil by moving through a long pan

______b. Allow oil to cool and thicken

______c. Heat oil that is recommended by manufacturer

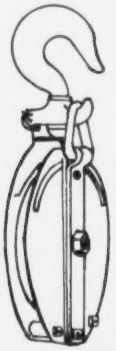
______d. Wipe off surplus oil as rope leaves the pan

______e. Check for frayed and worn parts

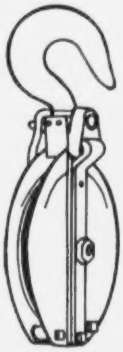
TEST

18. Label types of snatch blocks. Write the correct names in the blanks provided.

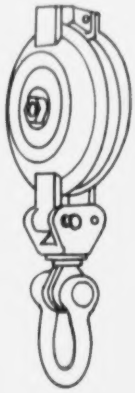
Swivel hook
Drop link
Self-locking
Upset swivel shackle
Swivel shackle
Swivel eye



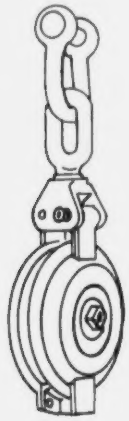
a. ____________________



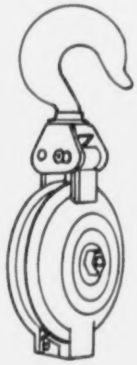
b. ____________________



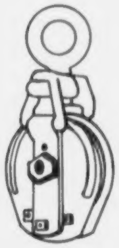
c. ____________________



d. ____________________



e. ____________________



f. ____________________

TEST

19. Select from the following list types of cable fittings. Write an "X" in the correct blanks

_____a. Drop-forged steel swivel hook and socket

_____b. Midget turnbuckle

_____c. Closed socket with chain

_____d. Closed socket for flat rope

_____e. Jaw and eye turnbuckle

_____f. Eye and bolt with nut

_____g. Swaged clevis fitting

_____h. Rope binding hook

_____i. Standard shackle

_____j. S-hook

_____k. Turnbuckle with spliced rope

_____l. Tie-out chain

_____m. Drop-forged steel hook with eye

_____n. Safety snap hook

_____o. Lock link wire chain

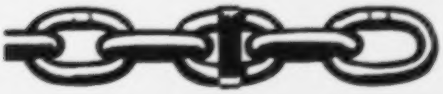
_____p. Drop-forged steel hook with shank

_____q. Screw pin shackle

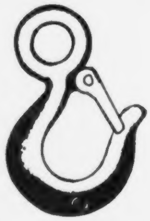
TEST

20. Identify the following types of towing chains and accessories. Write the correct names in the blanks provided.

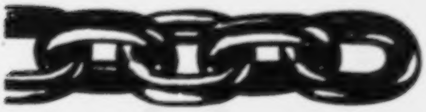
Shackles
Proof chain
Alloy chain
Swivels
Slip hook
BBB chain
Grab hook
Rings
High test chain
Safety hook



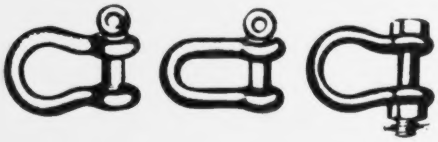
a. ______________________________



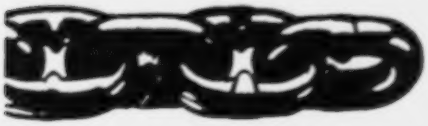
b. ______________________________



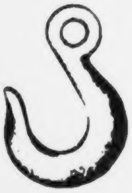
c. ______________________________



d. ______________________________

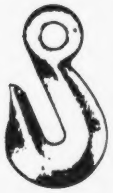


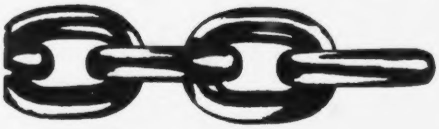
e. ______________________________



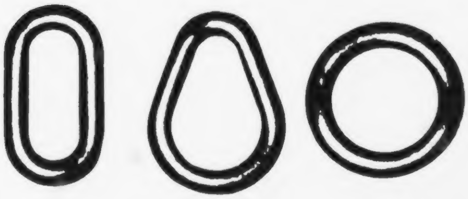
f. ______________________________

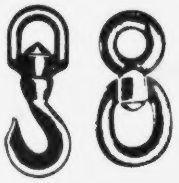
TEST





g. ______________________________ h. ______________________________





i. ______________________________ j. ______________________________

21. Select from the following list good rigging practices. Write an "X" in the correct blanks.

______a. Pad all sharp corners and edges

______b. Use tagline to pull loads

______c. Wrap rope around hook when not in use

______d. Center crane over load before lifting

______e. Give all hand signals clearly and correctly

______f. Secure all unused sling lines

______g. Turn hooks to face hoist

______h. Never allow a shackle to be pulled at an angle

______i. Unlock load as soon as it is low enough to reach

______j. Use a shackle whenever two or more ropes are to be used over a hook

TEST

(NOTE: Test items 22-28 list the assignment sheets and job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

22. Distinguish among types of knots.
23. Calculate safe working load (SWL) of different types and sizes of ropes.
24. Calculate sling stress.
25. Distinguish among hand signals used in rigging operations.
26. Calculate safe working load (SWL) of different sizes of wire rope.
27. Identify poor rigging practices.
28. Demonstrate the ability to
    a. Tie knots.
    b. Install wire rope clips.
    c. Rig and handle different types of loads using proper hand signals.

RIGGING
UNIT I

ANSWERS TO TEST

1. a. 4
   b. 15
   c. 9
   d. 12
   e. 7
   f. 11
   g. 3
   h. 8
   i. 1
   j. 6
   k. 14
   l. 17
   m. 16
   n. 2
   o. 5
   p. 10
   q. 13

2. a. Bridles
   b. Chain and shackle
   c. Bull chain
   d. Spreader bars
   e. Grommet sling
   f. Web sling
   g. Chokers (single slings)

3. a. Choker hitch choker
   b. Basket hitch sling
   c. Basket hitch choker
   d. Choker hitch sling
   e. Inverted basket hitch sling

4. a. Bight
   b. Running end
   c. Whipping
   d. Round turn
   e. Standing part
   f. Turn
   g. Underhand loop
   h. Overhand loop

5. a. 4
   b. 2
   c. 3
   d. 1
   e. 6
   f. 5
   g. 8
   h. 11
   i. 7
   j. 9
   k. 10

ANSWERS TO TEST

6. Answer should include any five of the following:

   a. Use personal protective devices such as goggles, gloves, safety shoes, and hard hats
   b. Use tag line to guide or steady load
   c. Do not walk under load
   d. Be sure load is balanced properly
   e. Do not overload equipment
   f. Stand clear when slings are heaved from under loads
   g. Be sure outriggers or stabilizers are in use and are on solid footing
   h. Be extra cautious around power lines
   i. Use corner saddles, padding, or wood blocking to protect slings from sharp bends and sharp edges
   j. Avoid heavy or continuous overloading
   k. Lubricate slings to prevent rust
   l. Be sure all hooks have safety snaps

7. a. 3 d. 4
   b. 6 e. 1
   c. 2 f. 5

8. Answer should include:

   a. Rope is normally made of three strands, each of which is made of several threads
   b. The rope itself is twisted in a right-hand direction while each strand is twisted in a left-hand direction and the individual threads are twisted in a right-hand direction
   c. Reversal of twist in strands gives the rope a balance or set which eliminates the tendency to unwind

9. Answer should include any six of the following:

   a. When taking rope from a coil, always remove it from the center in a counterclockwise direction
   b. When rope is not in use, it should be re-coiled in a clockwise direction
   c. When rope is attached to a hook, ring, or pulley block, a thimble should be placed in the loop or eye to reduce wear and to decrease stress
   d. Protect rope from moisture and weather as much as possible
   e. Do not disturb a frozen rope until completely thawed
   f. Keep rope away from acids, other chemicals, and heat
   g. Do not drag rope over ground or sharp edges
   h. If possible, do not make abrupt bends in rope
   i. Dirty rope should be washed and dried before being stored
   j. Store rope so that air may circulate around it
   k. If manila rope becomes stiff and hard because of being wet, treat with a thin lubricating oil or warm petrolatum (a jelly-like petroleum-based dressing.)

ANSWERS TO TEST

10. a. 720 lbs
    b. 2160 lbs
    c. 540 lbs
    d. 315 lbs
    e. 3240 lbs

11. a. Changing angle of sling leg may increase stress on the sling
    b. As the angle is reduced, lifting capacity is reduced very rapidly

12. a. $8^{3}/_{4}$ tons
    b. 1875 lbs
    c. 2 $^{1}/_{2}$ tons

13. a. 3
    b. 2
    c. 3
    d. 1
    e. 3
    f. 2
    g. 2
    h. 3

14. b, d, e, f, g

15. a. 1
    b. 2
    c. 4
    d. 3
    e. 5
    f. 6

16. a. 1 $^{1}/_{8}$tons
    b. 4 $^{1}/_{2}$ tons
    c. 8 tons
    d. 12 $^{1}/_{2}$ tons
    e. 15 $^{1}/_{8}$ tons

17. a. 3
    b. 5
    c. 2
    d. 4
    e. 1

ANSWERS TO TEST

18.
- a. Drop link
- b. Self-locking
- c. Swivel shackle
- d. Upset swivel shackle
- e. Swivel hook
- f. Swivel eye

19. a, c, d, g, i, k, m, n, p, q

20.
- a. High test chain
- b. Safety hook
- c. BBB chain
- d. Shackles
- e. Alloy chain
- f. Slip hook
- g. Grab hook
- h. Proof chain
- i. Rings
- j. Swivels

21. a, d, e, f, h, j

22. Evaluated to the satisfaction of the instructor

23. Evaluated to the satisfaction of the instructor

24. Evaluated to the satisfaction of the instructor

25. Evaluated to the satisfaction of the instructor

26. Evaluated to the satisfaction of the instructor

27. Evaluated to the satisfaction of the instructor

28. Performance skills evaluated to the satisfaction of the instructor

ARC WELDING
UNIT II

UNIT OBJECTIVE

After completing this unit, the student should be able to perform various welding jobs. The student will show this knowledge by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with arc welding to their correct definitions.
2. Write meanings of abbreviations associated with arc welding.
3. State safety precautions to observe when welding.
4. Name types of arc-welding machines.
5. Select from a list common tools and equipment used in arc welding.
6. Match to their correct definitions terms associated with welding materials.
7. List types of electrodes.
8. Select from a list common sizes of electrodes used in arc welding.
9. Interpret meanings of numbers in the AWS electrode classification system.
10. Distinguish between reverse and straight polarity.
11. Select from a list factors that determine correct polarities to use.
12. Select from a list purposes of electrode flux.
13. List factors to consider when selecting electrodes.
14. Describe effects of raising and lowering welding machine amperes.
15. Name methods of striking an arc.
16. Select from a list characteristics of proper arc length.
17. Identify parts of the welding process.
18. Match types of welds to their correct descriptions.

OBJECTIVE SHEET

19. Label types of welds.

20. Label types of weld joints.

21. Identify parts of groove and fillet welds.

22. List positions used in arc welding.

23. List reasons for poor welds.

24. List types of electrode motions (rod manipulations).

25. State characteristics of a good weld.

26. Match elements of welding symbols to their correct descriptions.

27. Draw symbols showing location of weld.

28. Identify basic weld symbols.

29. Distinguish between correct and incorrect drawings of symbols with one vertical side.

30. Identify supplementary symbols.

31. Interpret finish symbols used with contour symbols.

32. Demonstrate the ability to

    a. Start, stop, and restart a bead.

    b. Construct a pad weld.

    c. Construct a butt weld.

    d. Construct a lap-joint fillet weld in the overhead position.

    e. Construct a T-joint fillet weld in the vertical up position.

    f. Construct a square-groove butt-joint weld in the vertical down position.

ARC WELDING
UNIT II

SUGGESTED ACTIVITIES

I. Unit contents

   A. Objective sheet

   B. Suggested activities

   C. Transparency masters

      1. TM #1 — Common Tools and Equipment Used in Arc Welding
      2. TM #2 — Welding Circuit
      3. TM #3 — AWS Electrode Classification System
      4. TM #4 — Parts of the Welding Process
      5. TM #5 — Positions Used in Arc Welding
      6. TM #6 — Characteristics of a Good Weld
      7. TM #7 — Elements of Welding Symbols
      8. TM #8 — Standard Location of Welding Symbol Elements
      9. TM #9 — Application of Fillet Welding Symbol
      10. TM #10 — Application of Fillet Welding Symbol (Continued)
      11. TM #11 — Application of Plug Welding Symbol
      12. TM #12 — Application of Slot Welding Symbol
      13. TM #13 — Application of Spot Welding Symbol
      14. TM #14 — Application of Spot Welding Symbol (Continued)
      15. TM #15 — Application of Seam Welding Symbol
      16. TM #16 — Application of Seam Welding Symbol (Continued)
      17. TM #17 — Application of Square-Groove Welding Symbol
      18. TM #18 — Application of V-Groove Welding Symbol
      19. TM #19 — Application of Bevel-Groove Welding Symbol

SUGGESTED ACTIVITIES

20. TM #20 — Application of U-Groove Welding Symbol
21. TM #21 — Application of J-Groove Welding Symbol
22. TM #22 — Application of Flared V-Groove Welding Symbol
23. TM #23 — Application of Flared Bevel-Groove Welding Symbol
24. TM #24 — Application of Edge-Flange Welding Symbol
25. TM #25 — Application of Corner-Flange Welding Symbol
26. TM #26 — Designation of Location and Extent of Fillet Welds
27. TM #27 — Designation of Location and Extent of Fillet Welds (Continued)
28. TM #28 — Designation of Extent of Welding
29. TM #29 — Application of Dimensions to Spot Welding Symbols
30. TM #30 — Application of Dimensions to Spot Welding Symbols (Continued)
31. TM #31 — Application of Dimensions to Seam Welding Symbols
32. TM #32 — Application of Dimensions to Seam Welding Symbols (Continued)

D. Information sheet

E. Job sheets

1. Job Sheet #1 — Start, Stop, and Restart a Bead
2. Job Sheet #2 — Construct a Pad Weld
3. Job Sheet #3 — Construct a Butt Weld
4. Job Sheet #4 — Construct a Lap-Joint Fillet Weld in the Overhead Position
5. Job Sheet #5 — Construct a T-Joint Fillet Weld in the Vertical Up Position
6. Job Sheet #6 — Construct a Square-Groove Butt-Joint Weld in the Vertical Down Position

F. Test

G. Answers to test

SUGGESTED ACTIVITIES

II. Instructor's guide

A. Review unit and plan presentation.

B. Order materials to supplement unit.

1. Electrode selection wall chart and electrode guide books

   (NOTE: Obtain from your local welding supplier.)

2. Film — *Arc Welding*, 30 minutes, color, Association Films, 1971. Available from Association Films, 600 Grand Avenue, Richfield, New Jersey 07657.

   (NOTE: This film explains major arc welding processes, required equipment, and progress made in the field. It is available to Oklahoma teachers on a free-loan basis from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center Film Library, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074. Out-of-state teachers must order from the address listed above.)

3. Clean $^{1}/_{4}$-inch, $^{3}/_{8}$-inch, and $^{3}/_{16}$-inch plates and coupons for the students to weld on

   (NOTE: Check other catalogs and resources, and order materials needed.)

4. Order transparencies and competency profiles.

   (NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W., Washington, DC 20006, phone 202-393-2040.)

C. Make sample pad and butt welds like those to be made in the job sheets, as well as samples of the different types of welds and joints illustrated on the transparencies.

D. Check all welding equipment for proper condition and quantity: helmets, electrodes, helmet lenses, safety glasses, and gloves.

E. Before starting the unit, have students begin bringing to class proper protective clothing; provide a storage place for the clothes.

F. Introduce unit by emphasizing the benefits of knowing how to arc weld.

SUGGESTIONS:

- Stress the increased job opportunities that exist for carpenters who are also welders.

SUGGESTED ACTIVITIES

- Emphasize to students that they can save money by making their own repairs and construction projects for which they would otherwise have to hire a welder.

G. Provide students with objective sheet.

H. Discuss unit and specific objectives.

SUGGESTIONS:

- Emphasize the importance of being familiar with the terms and definitions in order to understand and be able to communicate the technical terminology associated with arc welding.
- Point out how the information in the unit will build through the unit to prepare the student to actually perform the job sheets at the end of the unit.

I. Provide students with information and job sheets.

J. Discuss information sheet.

1. Discuss terms and definitions associated with arc welding; use Information Sheet, Section I.

   SUGGESTIONS:

   - Show Transparency #1 and actual equipment to illustrate some of the terms and definitions.
   - Using a small ball-peen hammer and metal plate, crumble flux from an electrode when discussing electrodes and flux.

2. Use Information Sheet, Section II to discuss abbreviations associated with arc welding; explain how the abbreviations relate to arc welding.

3. Use Information Sheet, Section III to discuss safety precautions in arc welding.

   SUGGESTIONS:

   - Cite instances with which you are familiar that may have resulted in an accident or tragedy due to someone's lack of observing and practicing proper safety precautions.
   - Allow students to share instances that they may know of that resulted from not observing proper safety precautions.
   - Specifically discuss each safety precaution as it relates to personal safety and the safety of others in the immediate work area.

SUGGESTED ACTIVITIES

- Discuss the importance of using the proper lens as shown in the table below.

EXAMPLE:

TABLE 1

LENS—SHADE SELECTOR	
Shade Number	**Type of Operation**
2	Soldering
3 or 4	Torch brazing
 3 or 4 3 or 5 5 or 6	Oxygen cutting 0 to 1 inch 1 to 6 inches 6 inches and over
 4 or 5 5 or 6 6 or 8	Gas welding 0 to 1/3 inch 1/8 to 1/2 inch 1/2 inch and over
9 to 14	Shielded metal-arc welding 1/16-, 3/4-, 1/8-, 5/32-inch electrodes
9 to 14	Gas-metal arc welding
9 to 14	Gas-tungsten arc welding nonferrous gas-metal arc welding 1/16-, 3/32-, 1/8-, 5/32-inch electrodes
9 to 14	Gas-tungsten arc welding (ferrous), gas-metal arc welding (ferrous) 1/16-, 3/32-, 1/8-, 5/32-inch electrodes

4. Discuss the different kinds of arc welding machines and their uses; use Information Sheet, Section IV.

SUGGESTIONS:

- Take students on a tour of the shop to show them as many of the types of welding machines as are available.
- Point out that welding on AC and DC machines using a stick electrode is referred to as *shielded metal arc welding (SMAW)*; welding on a TIG machine is referred to as *gas tungsten arc welding (GTAW)*; and welding on an MIG machine is referred to as *gas metal arc welding (GMAW)*.
- Give examples of the uses for each kind of welding machine.
- Invite a local supplier to discuss kinds of welding machines and their uses.

SUGGESTED ACTIVITIES

5. Discuss common arc welding equipment; use Information Sheet, Section IV.

   SUGGESTIONS:

   - Take students to the shop to show them the components that make up the arc welding equipment.
   - Explain to the students what to look for when checking the equipment to make sure that it is in good condition.
   - Demonstrate to the students how to make helmet adjustments and lens changes.
   - Show students the result of handling hot metal with leather gloves.
   - Show the film, *Arc Welding*. After showing the film, allow for student/teacher discussion of the film.

6. Use Information Sheet, Section VI to discuss terms associated with welding materials; relate the terms to the welding process using Transparency #2 and actual materials.

7. Discuss electrode types and sizes and the AWS electrode classification system. Combine Sections VII through IX of the Information Sheet and Transparency #3.

   SUGGESTIONS:

   - Discuss various types, sizes, and classifications of electrodes. Show the students examples of each type, and pass examples around the class.
   - Point out the types of information that can be obtained from the electrode selection wall chart and the electrode pocket guide books.

8. Use Information Sheet, Sections X and XI and Transparency #2 to discuss polarity and factors in determining correct polarity; demonstrate how to use an electrode guide book.

9. Use Information Sheet, Sections XII and XIII and an electrode handbook to discuss selection of electrodes; relate electrodes commonly used in commercial carpentry to their uses.

10. Discuss the effects of raising and lowering current settings on arc welding machines. Use Information Sheet, Section XIV.

    SUGGESTIONS:

    - Using thin plate, demonstrate how raising the current can produce enough heat to burn a hole completely through the metal. Point out that a much lower current setting will not burn through the metal.

SUGGESTED ACTIVITIES

- Explain that on the electrode selection wall chart, different current settings are suggested for different thicknesses of metal and different electrode sizes.

11. Discuss methods of establishing an arc. Use Information Sheet, Section XV.

    SUGGESTION:

    - Demonstrate the procedures in the classroom, using a metal plate and an electrode, or take students to the shop and equip them with helmets so that they may watch an on-the-job demonstration.

12. Discuss characteristics of proper arc length; use Information Sheet, Section XVI.

    SUGGESTION:

    - Demonstrate arc length in the shop, with small groups of students gathered around a welding table where they can see the length of arc being maintained.

13. Discuss parts of the welding process. Use Information Sheet, Section XVII and Transparency #4.

    SUGGESTIONS:

    - Show and discuss Transparency #4. Emphasize again the importance of proper arc length.

    - Demonstrate the actual welding process in the shop by running a bead.

    - Invite a local welder to demonstrate the welding process to the students. Have the welder discuss the important aspects of the process.

14. Use Information Sheet, Sections XVIII through XXI to discuss types of welds and joints.

    SUGGESTIONS:

    - Show prepared samples of actual weld joints.

    - Point out that the bead weld is used to make an edge joint.

    - Point out that a groove weld is used to make a butt joint.

    - Point out that the fillet weld is used to make T, corner, and lap joints.

    - Demonstrate Job Sheets 1 through 3.

SUGGESTED ACTIVITIES

15. Discuss weld positions, using Information Sheet, Section XXIII and Transparency #5.

    SUGGESTIONS:

    - In the classroom, simulate the positions with a hand-held piece of metal and hand-held electrode.
    - Demonstrate the positions by performing welding activities in the shop.
    - Invite a local welder to demonstrate the various welding positions.
    - Relate the positions to commercial carpentry tasks.

16. Discuss reasons for poor welds. Use Information Sheet, Section XXIV.

    SUGGESTIONS:

    - Point out to the students that much of the information discussed thus far relates and applies to making either high-quality or poor welds.
    - Show and discuss prepared examples of poor welds as related to each of the reasons for poor welds listed.
    - Demonstrate in the shop each of the reasons for poor welds listed. Show the students the resultant poor welds.

17. Use Information Sheet, Section XXIV to discuss types of electrode motions; demonstrate the motions using electrodes in the classroom and allow students to practice.

18. Use Information Sheet, Section XXV, Transparency #6, and actual welds to discuss characteristics of a good weld.

    SUGGESTIONS:

    - Relate the characteristics of a good weld to reasons for poor welds.
    - Provide students with welds and have them evaluate the welds in terms of the listed characteristics.
    - Explain how you will use the characteristics of a good weld to evaluate the students' projects.
    - Demonstrate remaining job sheets and allow students to practice procedures.

SUGGESTED ACTIVITIES

19. Use remaining sections of Information Sheet and remaining transparencies to discuss welding symbols.

    SUGGESTIONS:

    - Show the students examples of various symbols on commercial blueprints and details.
    - Have an architect or architectural engineer explain the use of symbols.
    - Visit a job site to see symbols translated into welds.
    - Make flashcards of symbols and have students explain what they mean.
    - Provide students with weld symbols and specifications and have them make the welds described.

K. Review unit.

L. Give test.

M. Critique test and discuss in class.

N. Reteach and retest if required.

O. Complete appropriate sections of competency profile.

III. Unit references

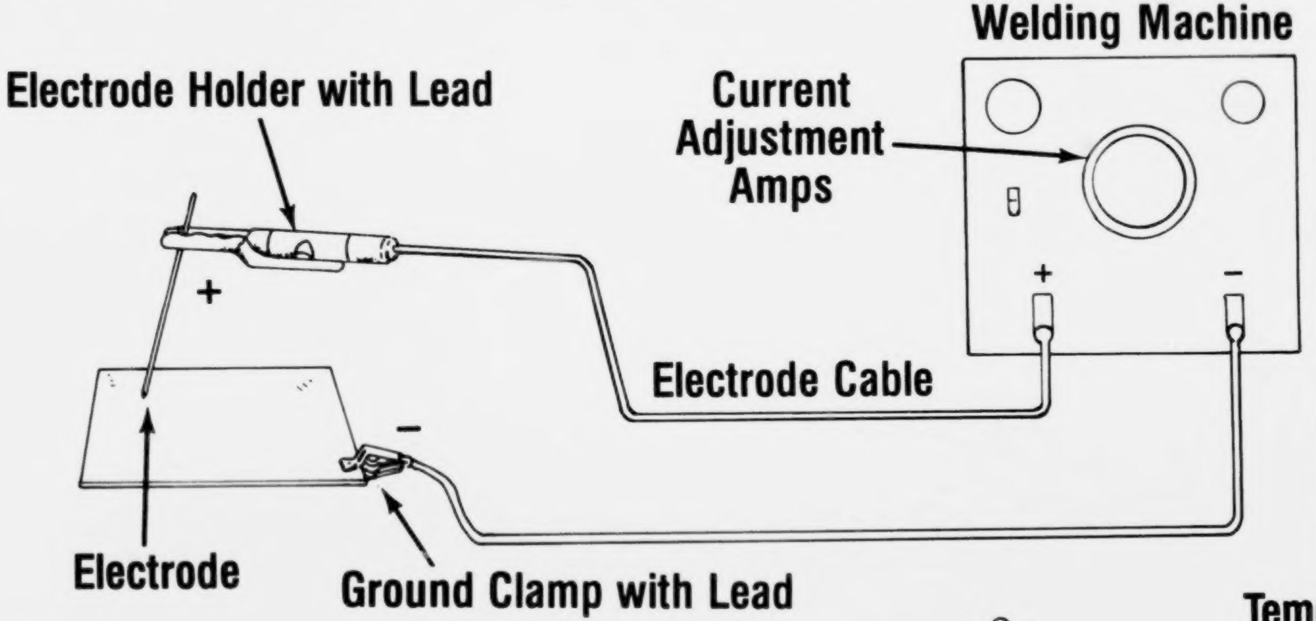
A. Hendrix, Laborn J., "Bud." *Millwright Instructional Materials*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1980.

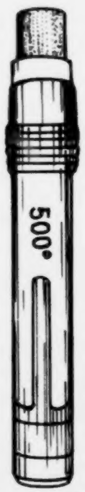
B. Hendrix, Laborn J., "Bud." *Heavy Equipment Mechanic*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1984.

C. Jefferson, T.B. *The Welding Encyclopedia*. Morton Grove, Illinois: Monticello Books, 1968.

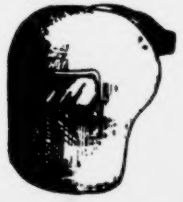
D. *Symbols for Welding and Nondestructive Testing*. Miami, Florida: American Welding Society, Inc., 1979.

Common Tools and Equipment Used in Arc Welding

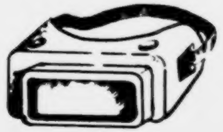

Welding Machine
Electrode Holder with Lead
Current Adjustment Amps
+
–
+
–
Electrode Cable
Electrode
Ground Clamp with Lead



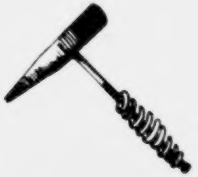
Temp-Stick



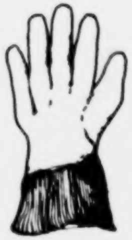
Shield or Helmet



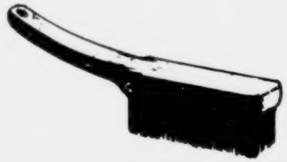
Welding Goggles



Chipping Hammer



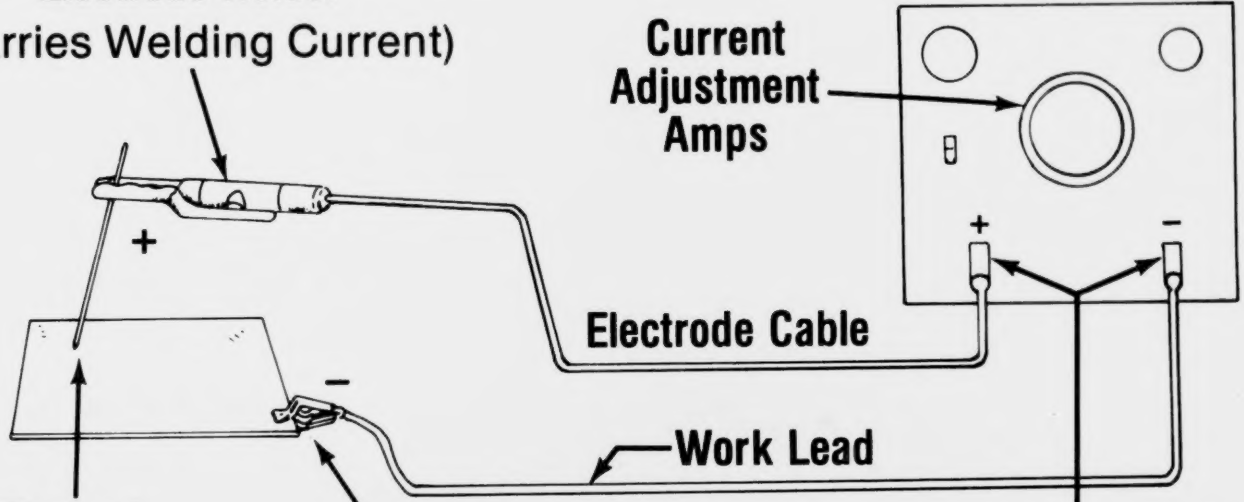
Leather Gloves



Wire Brush

Welding Circuit

(Reverse Polarity)



Electrode Holder

(Carries Welding Current)

Welding Machine

Current Adjustment Amps

+

–

+

–

Electrode Cable

Work Lead

Electrode

(Diameters: 1/16 to 5/16 Inch; Most Common Length: 14 Inches)

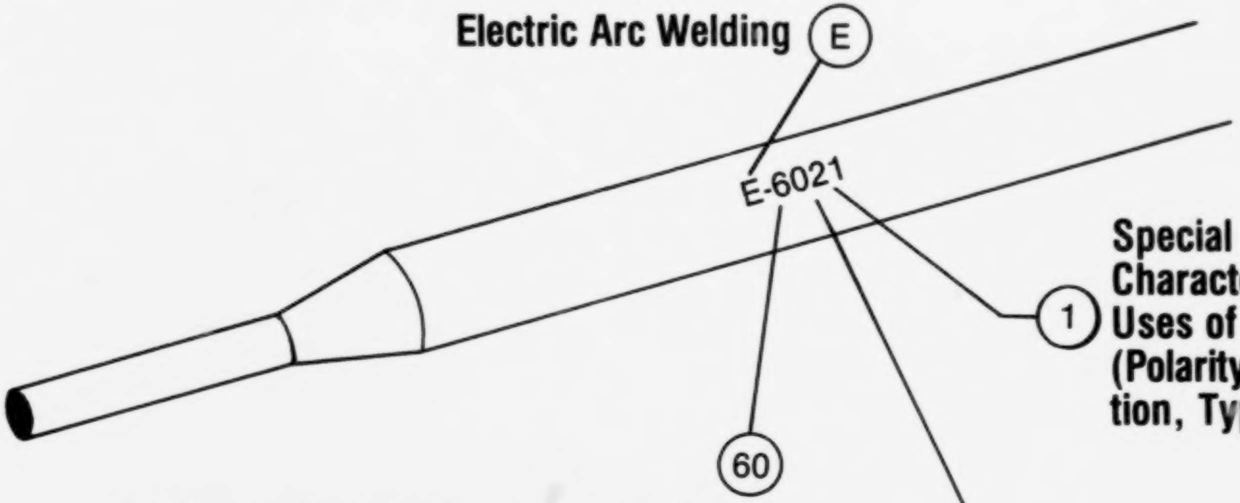
Grounded Base Metal

(Completes Welding Circuit)

D C Current Polarity

Reverse:	Straight:
1. Electrode (+)	1. Electrode (–)
2. Current flows from base metal to electrode	2. Current flows from electrode to base metal
3. Two-thirds heat at (+) electrode; one-third heat at (–) work	3. Two-thirds heat at (–) work; one-third heat at (+) electrode

AWS Electrode Classification System



Electric Arc Welding

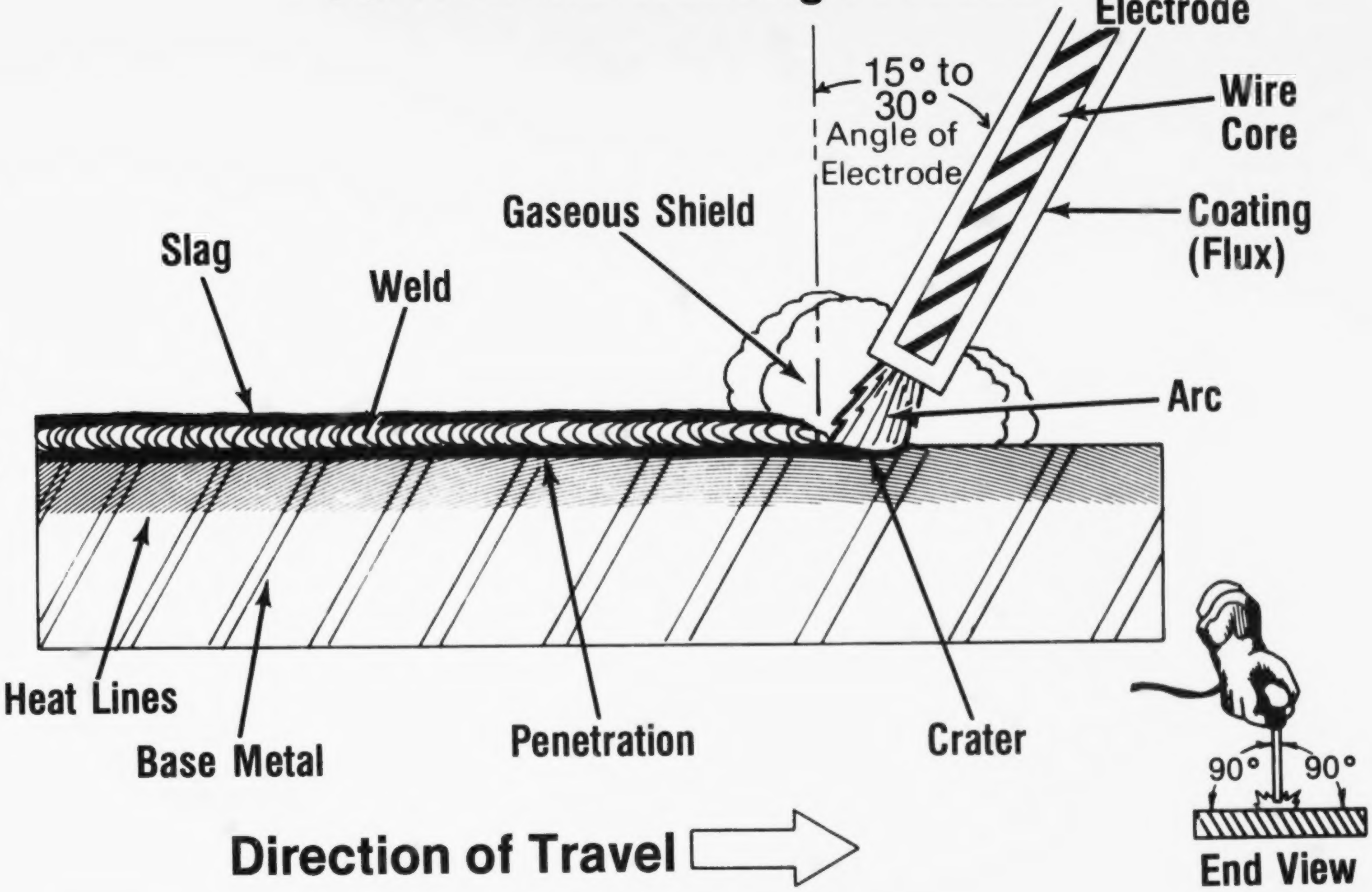
Special Characteristics and Uses of the Electrode (Polarity, Penetration, Type of Welder)

Minimum Tensile Strength Deposited in Thousands of Pounds per Square Inch

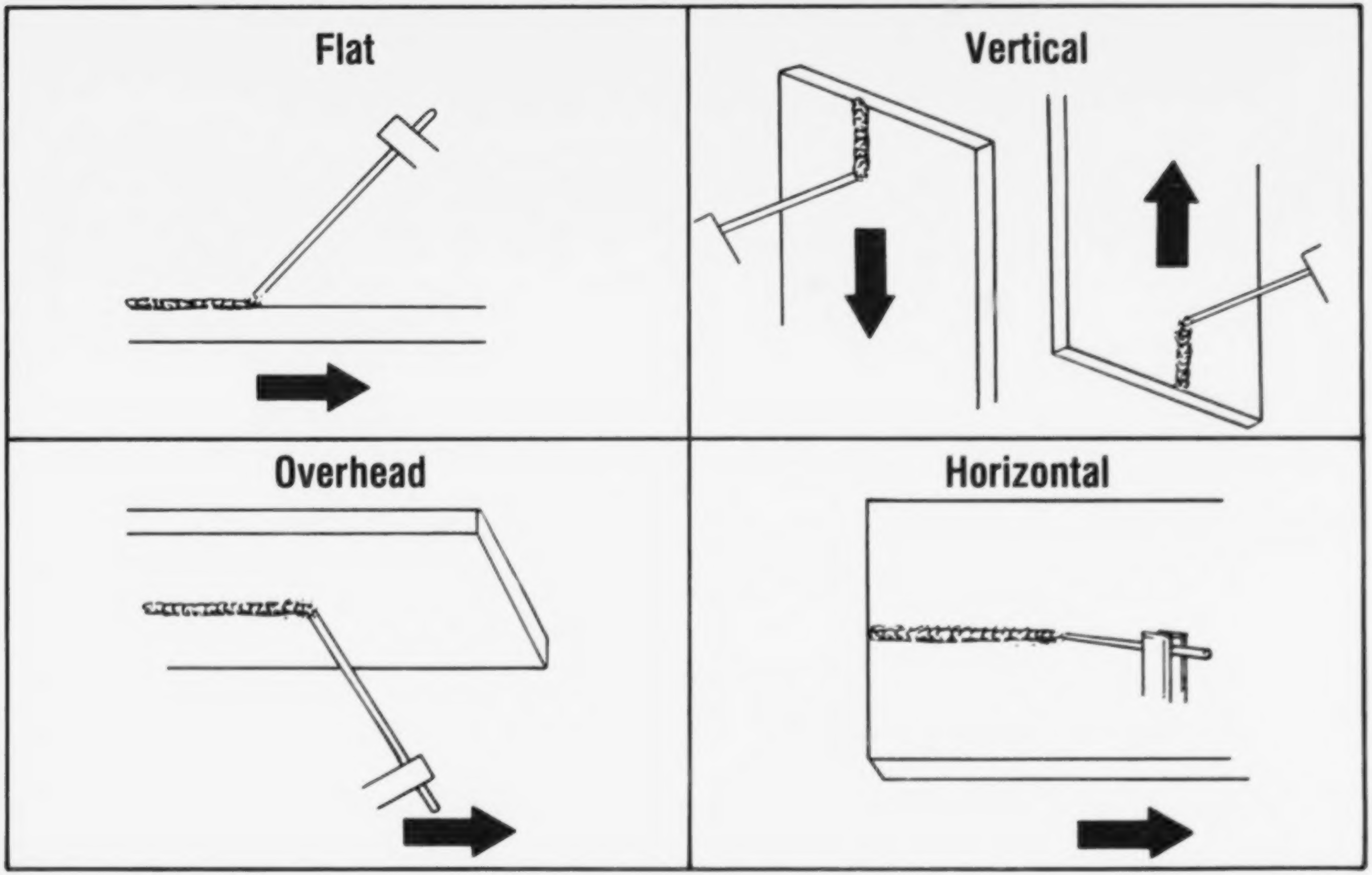
WeldingPosition
(1--Indicates All Positions,
2--Indicates Flat and Horizontal Only,
3--Indicates Flat Only)

E-6021 Mild-Steel Electrode

Parts of the Welding Process

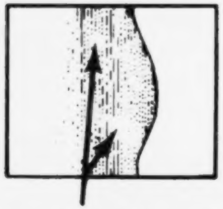

Electrode
15° to 30° Angle of Electrode
Wire Core
Coating (Flux)
Gaseous Shield
Slag
Weld
Arc
Heat Lines
Base Metal
Penetration
Crater
90°
90°
End View
Direction of Travel

Positions Used in Arc Welding


Flat
Vertical
Overhead
Horizontal

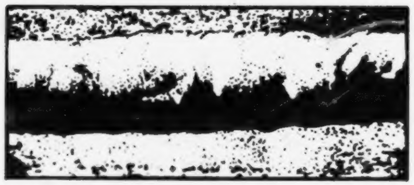
Characteristics of a Good Weld

End View



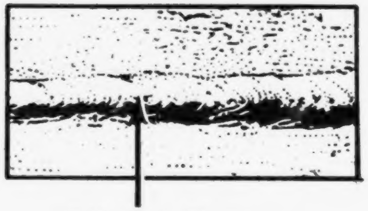
Even Penetration (Well-Fused)

Top View



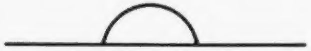
Even Ripple

Bottom View



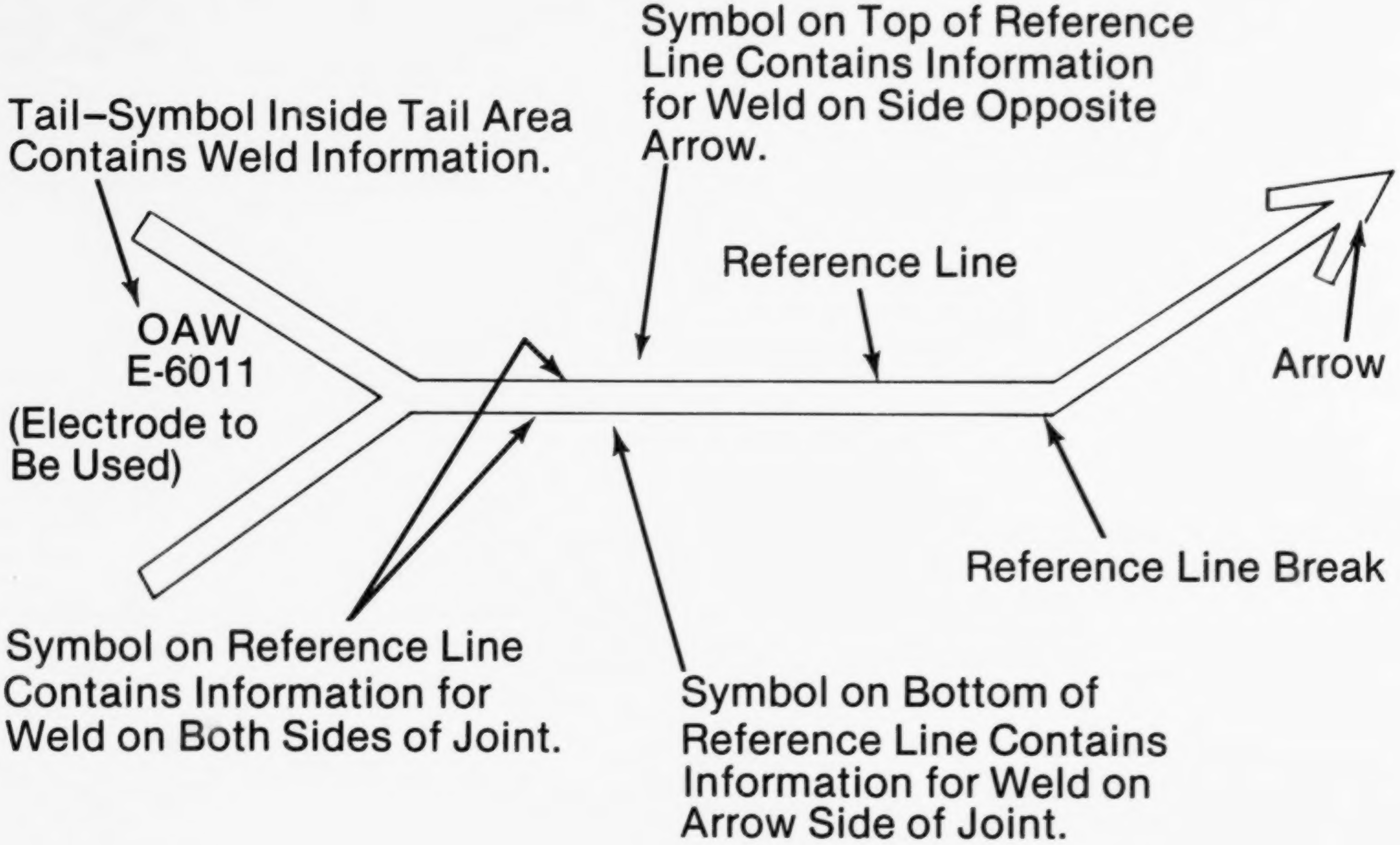
Slight Crown

End View



Correct Bead Size

Elements of Welding Symbol



Symbol on Top of Reference Line Contains Information for Weld on Side Opposite Arrow.

Tail–Symbol Inside Tail Area Contains Weld Information.

Reference Line

OAW
E-6011
(Electrode to Be Used)

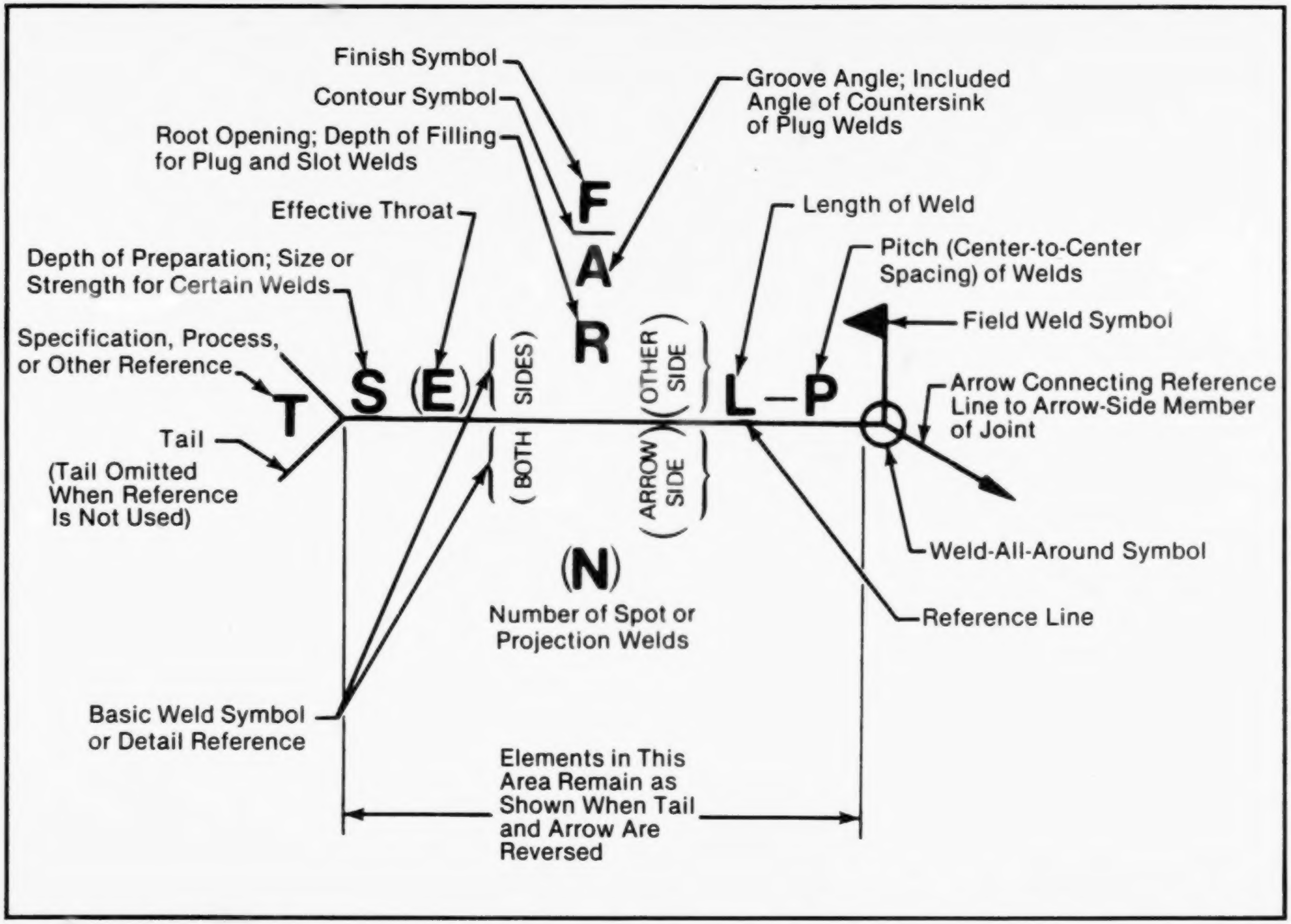
Arrow

Reference Line Break

Symbol on Reference Line Contains Information for Weld on Both Sides of Joint.

Symbol on Bottom of Reference Line Contains Information for Weld on Arrow Side of Joint.

Standard Location of Welding Symbol Elements


Finish Symbol
Contour Symbol
Root Opening; Depth of Filling for Plug and Slot Welds
Effective Throat
Depth of Preparation; Size or Strength for Certain Welds
Specification, Process, or Other Reference
Tail
(Tail Omitted When Reference Is Not Used)
Groove Angle; Included Angle of Countersink of Plug Welds
Length of Weld
Pitch (Center-to-Center Spacing) of Welds
Field Weld Symbol
Arrow Connecting Reference Line to Arrow-Side Member of Joint
Weld-All-Around Symbol
Reference Line
F
A
R
T
S
(E)
L–P
(N)
(BOTH SIDES)
(OTHER SIDE)
(ARROW SIDE)
Number of Spot or Projection Welds
Basic Weld Symbol or Detail Reference
Elements in This Area Remain as Shown When Tail and Arrow Are Reversed

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TM #8

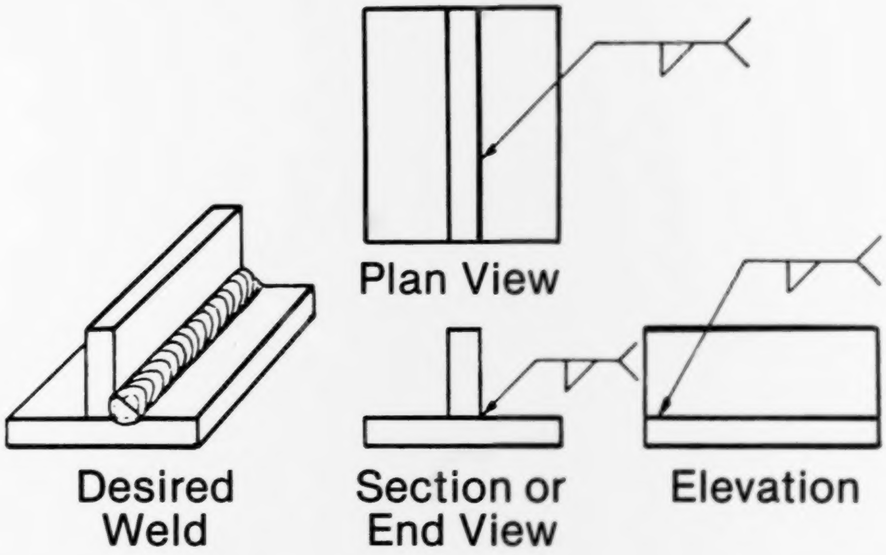
CC - 165-D

1293

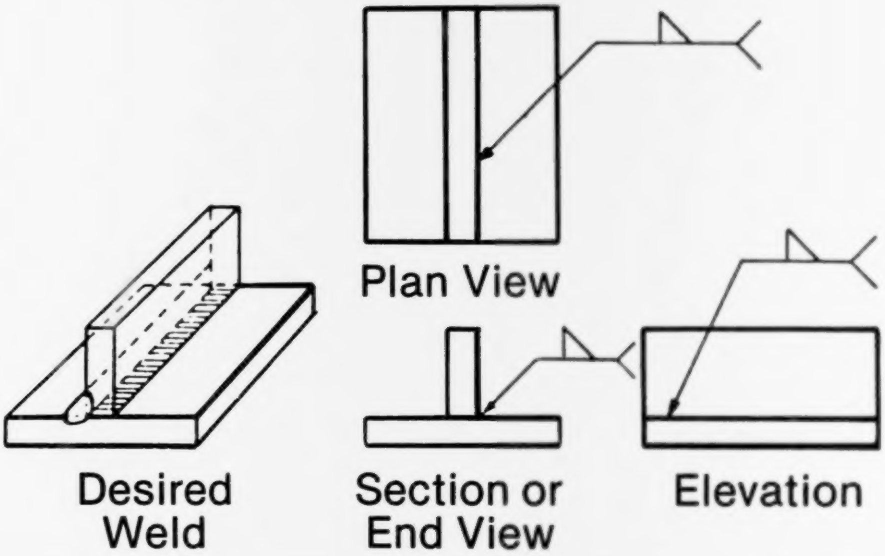
1294

Application of Fillet Welding Symbol

Arrow Side of Fillet Welding Symbol


Plan View
Desired Weld
Section or End View
Elevation

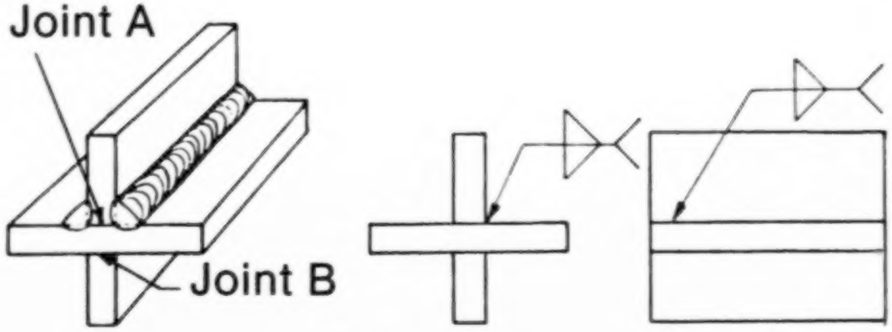
Other Side of Fillet Welding Symbol


Plan View
Desired Weld
Section or End View
Elevation

1295

Application of Fillet Welding Symbol
(Continued)

Both Sides of Fillet Welding Symbol for One Joint

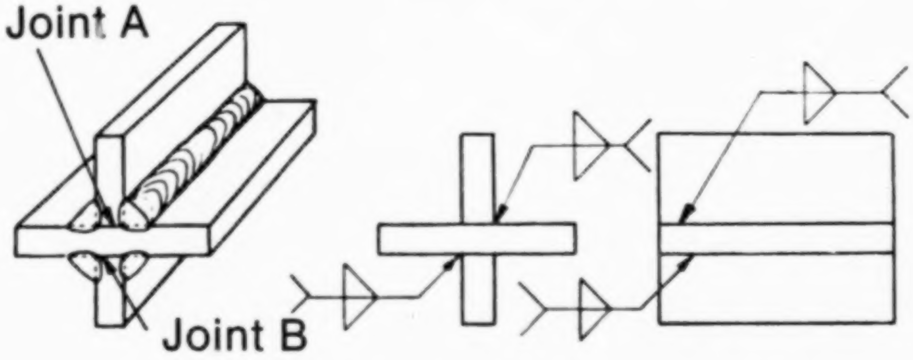

Joint A
Joint B

Desired Weld

Section or End View

Elevation

Both Sides of Fillet Welding Symbol for Two Joints


Joint A
Joint B

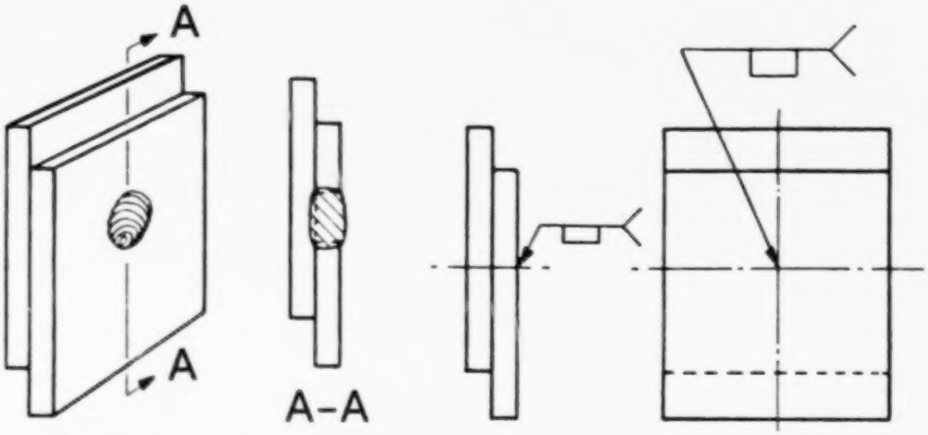
Desired Weld

Section or End View

Elevation

Application of Plug Welding Symbol

Arrow Side of Plug Welding Symbol

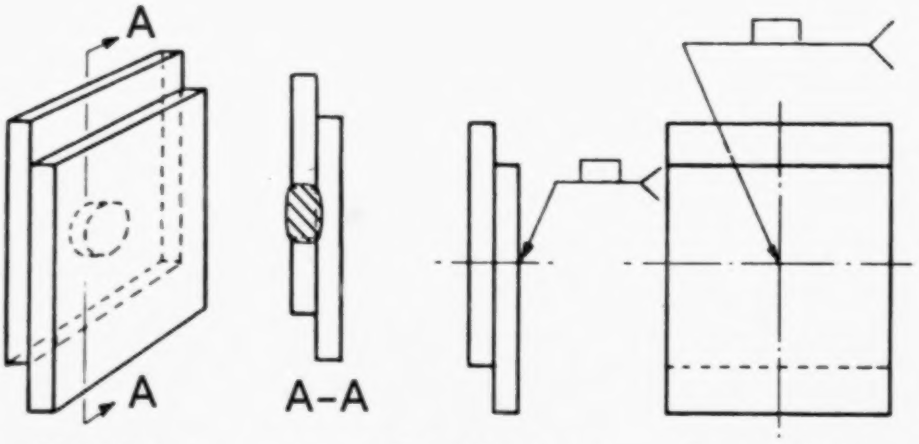


Desired Weld

Section or End View

Elevation

Other Side of Plug Welding Symbol



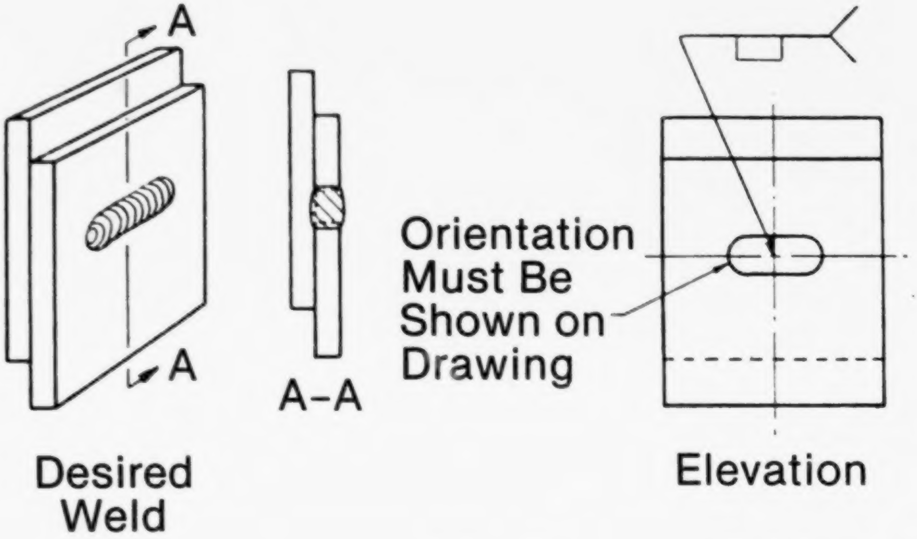
Desired Weld

Section or End View

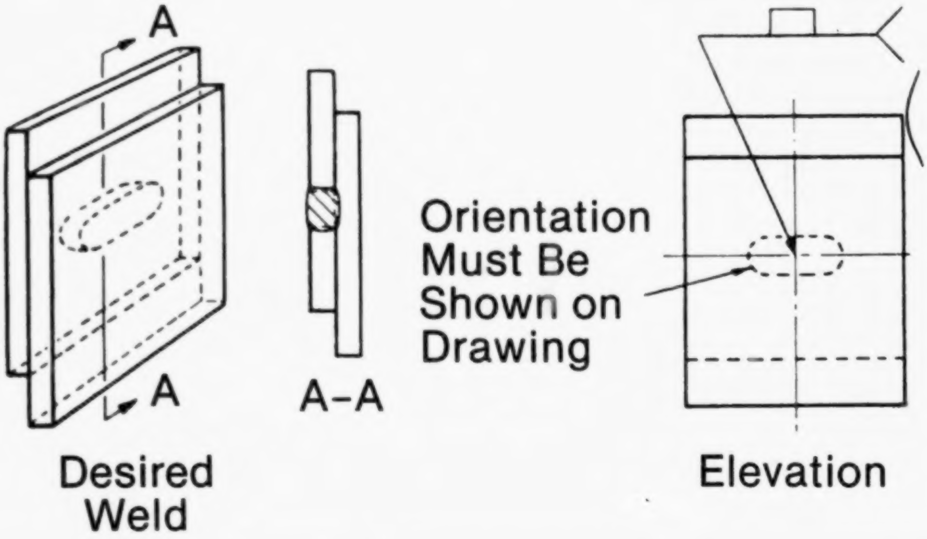
Elevation

Application of Slot Welding Symbol

Arrow Side of Slot Welding Symbol


A
A
A–A
Orientation
Must Be
Shown on
Drawing
Desired
Weld
Elevation

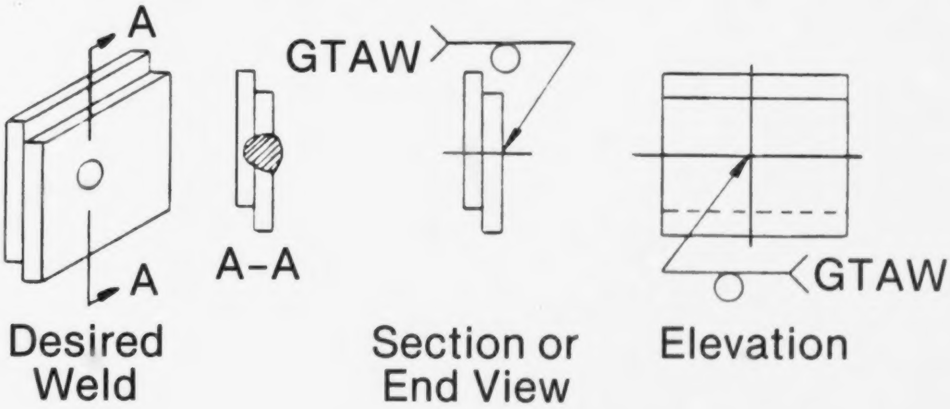
Other Side of Slot Welding Symbol


A
A
A–A
Orientation
Must Be
Shown on
Drawing
Desired
Weld
Elevation

Application of Spot Welding Symbol

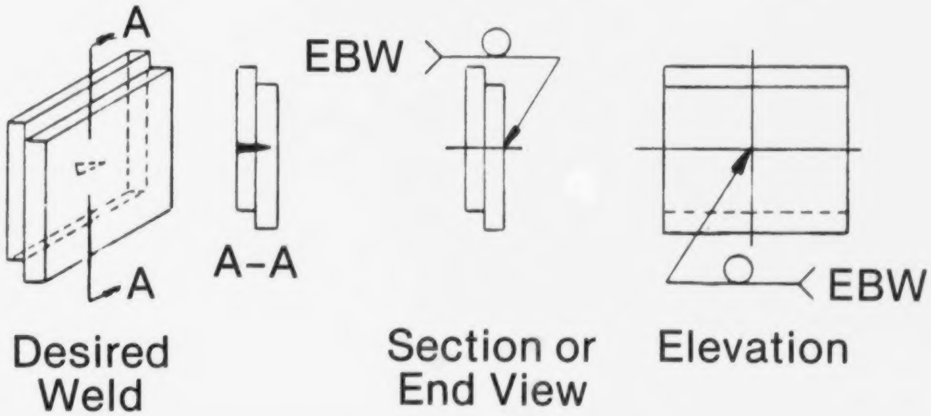
Arrow Side of Spot Welding Symbol

(Gas Tungsten-Arc Spot)


A
GTAW
A
A–A
GTAW
Desired Weld
Section or End View
Elevation

Other Side of Spot Welding Symbol

(Electron Beam Spot)

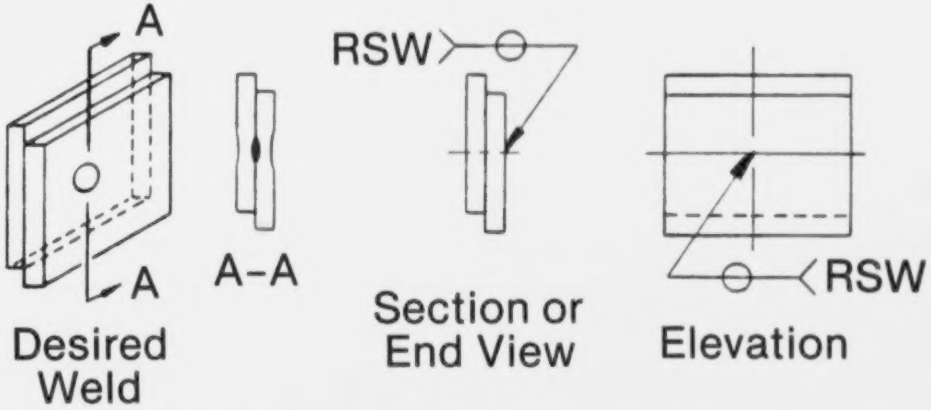

A
EBW
A
A–A
EBW
Desired Weld
Section or End View
Elevation

Application of Spot Welding Symbol

(Continued)

No Arrow- or Other-Side Reference or Significance

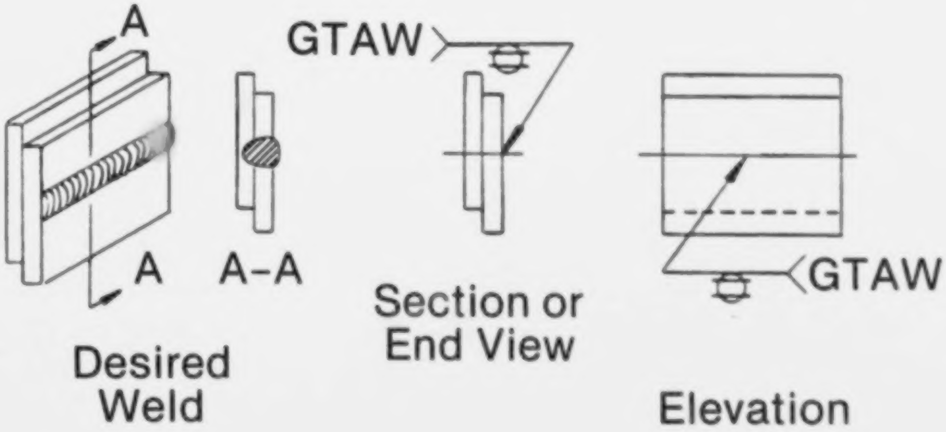
(Resistance Spot)


A
A
A–A
RSW
RSW
Desired Weld
Section or End View
Elevation

Application of Seam Welding Symbol

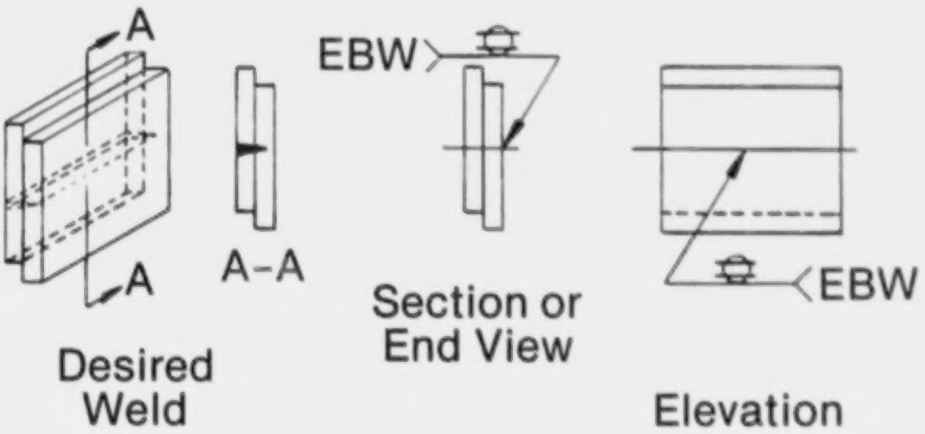
Arrow Side of Seam Welding Symbol

(Gas Tungsten-Arc Spot)


A
A
A–A
GTAW
GTAW
Section or End View
Desired Weld
Elevation

Other Side of Side Seam Welding Symbol

(Electron Beam Spot)

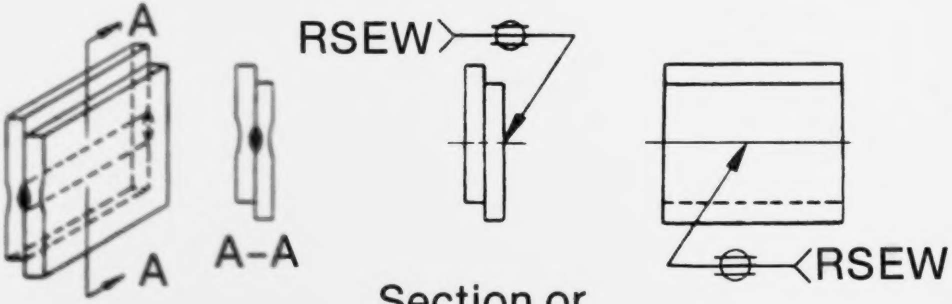

A
A
A–A
EBW
EBW
Section or End View
Desired Weld
Elevation

Application of Seam Welding Symbol

(Continued)

No Arrow- or Other-Side Reference or Significance

(Resistance Spot)



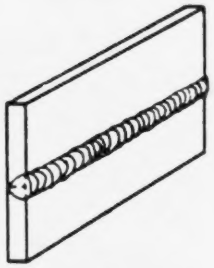
Desired Weld

Section or End View

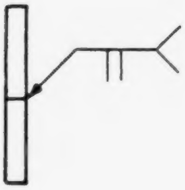
Elevation

Application of Square-Groove Welding Symbol

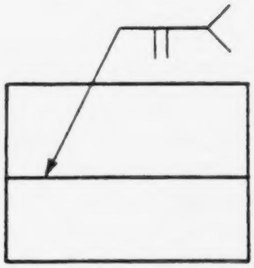
Arrow Side of Square-Groove Welding Symbol



Desired Weld

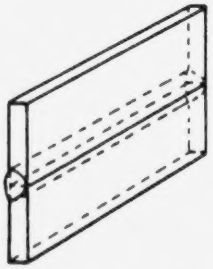


Section or End View

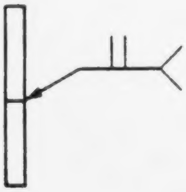


Elevation

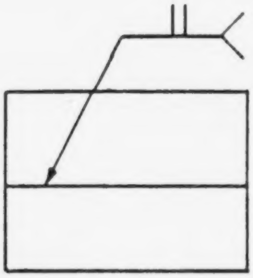
Other Side of Square-Groove Welding Symbol



Desired Weld

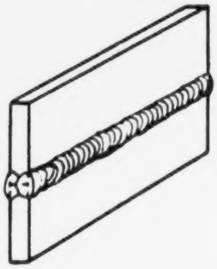


Section or End View

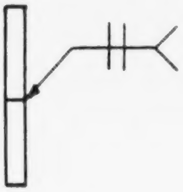


Elevation

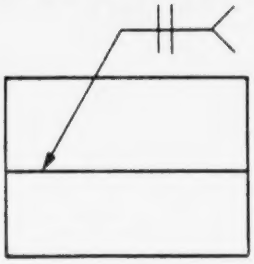
Both Sides of Square-Groove Welding Symbol



Desired Weld



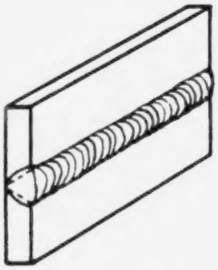
Section or End View



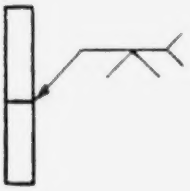
Elevation

Application of V-Groove Welding Symbol

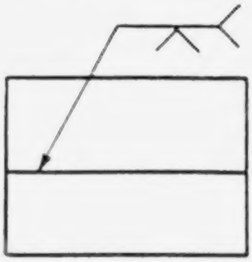
Arrow Side of V-Groove Welding Symbol



Desired
Weld

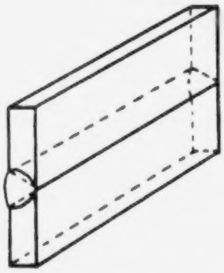


Section or
End View

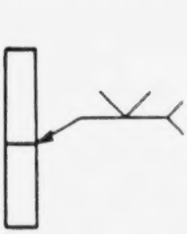


Elevation

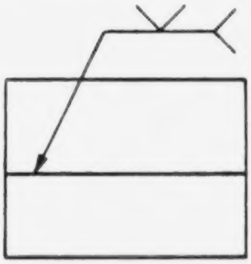
Other Side of V-Groove Welding Symbol



Desired
Weld

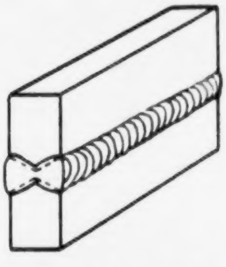


Section or
End View

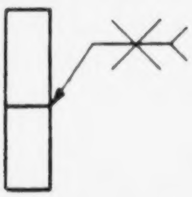


Elevation

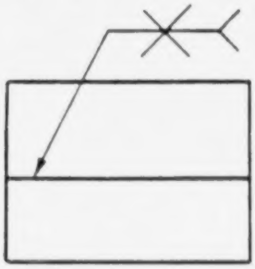
Both Sides of V-Groove Welding Symbol



Desired
Weld



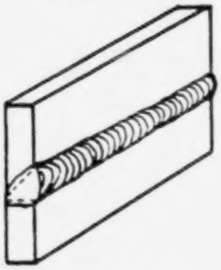
Section or
End View



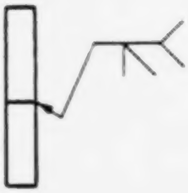
Elevation

Application of Bevel-Groove Welding Symbol

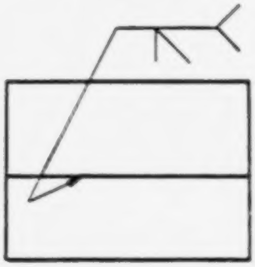
Arrow Side of Bevel-Groove Welding Symbol



Desired Weld

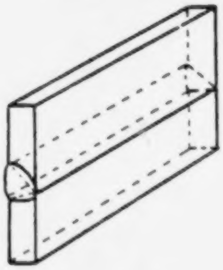


Section or End View

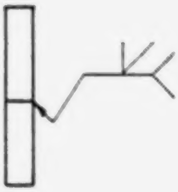


Elevation

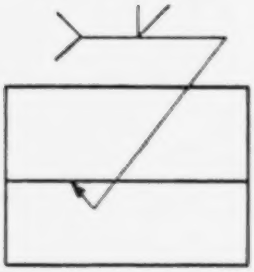
Other Side of Bevel-Groove Welding Symbol



Desired Weld

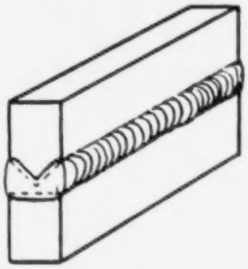


Section or End View

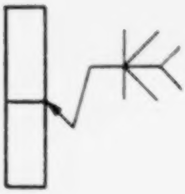


Elevation

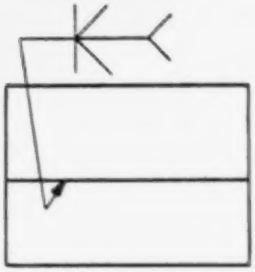
Both Sides of Bevel-Groove Welding Symbol



Desired Weld



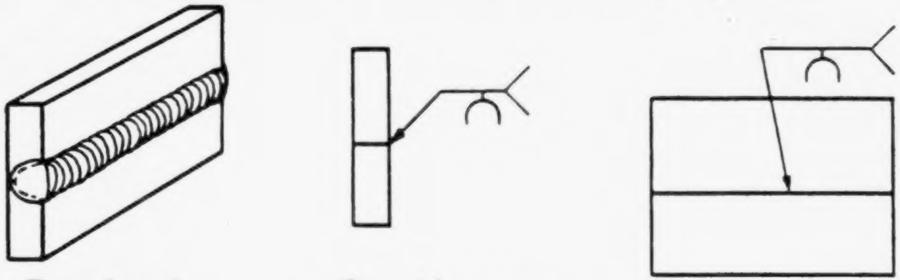
Section or End View



Elevation

Application of U-Groove Welding Symbol

Arrow Side of U-Groove Welding Symbol

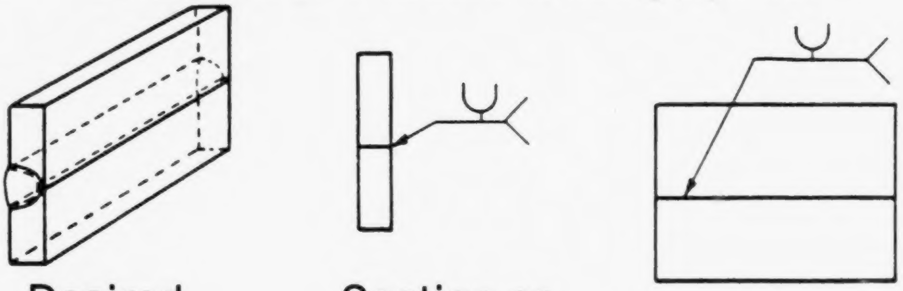


Desired Weld

Section or End View

Elevation

Other Side of U-Groove Welding Symbol

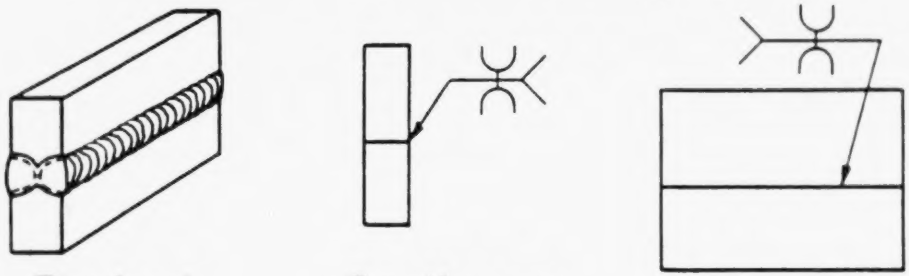


Desired Weld

Section or End View

Elevation

Both Sides of U-Groove Welding Symbol



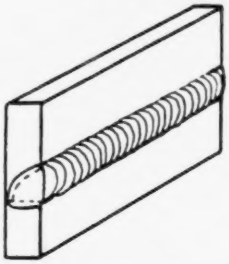
Desired Weld

Section or End View

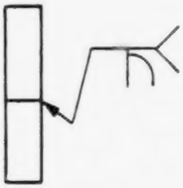
Elevation

Application of J-Groove Welding Symbol

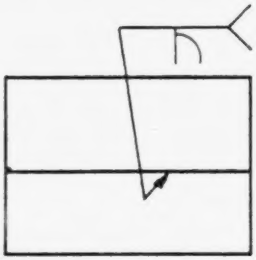
Arrow Side of J-Groove Welding Symbol



Desired Weld

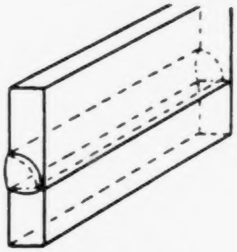


Section or End View

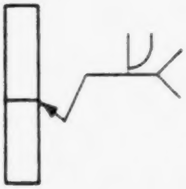


Elevation

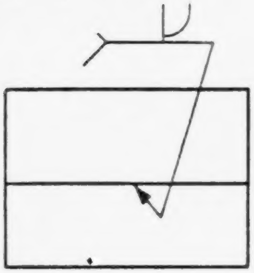
Other Side of J-Groove Welding Symbol



Desired Weld

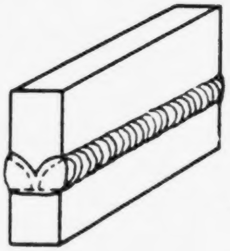


Section or End View

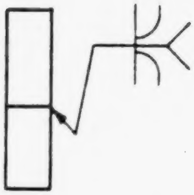


Elevation

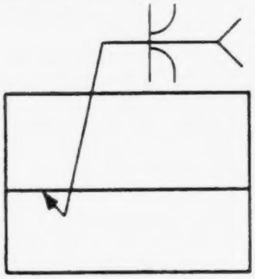
Both Sides of J-Groove Welding Symbol



Desired Weld



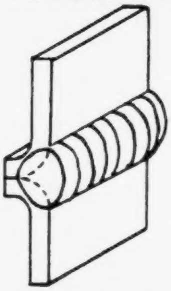
Section or End View



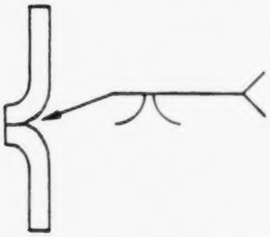
Elevation

Application of Flared V-Groove Welding Symbol

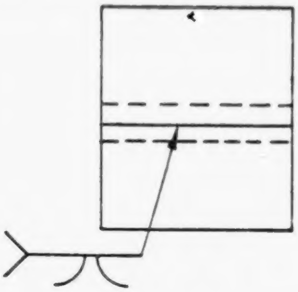
Arrow Side of Flared V-Groove Welding Symbol



Desired Weld

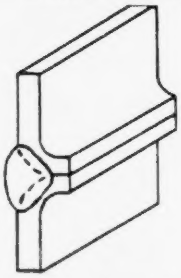


Section or End View

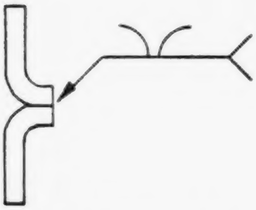


Elevation

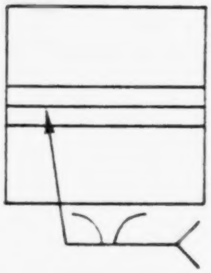
Other Side of Flared V-Groove Welding Symbol



Desired Weld

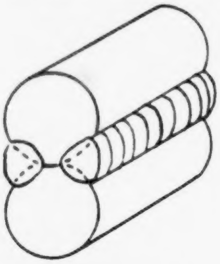


Section or End View

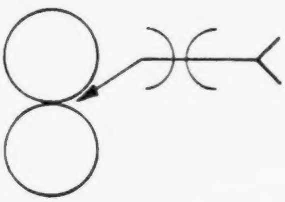


Elevation

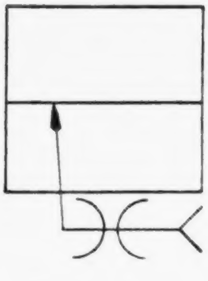
Both Sides of Flared V-Groove Welding Symbol



Desired Weld



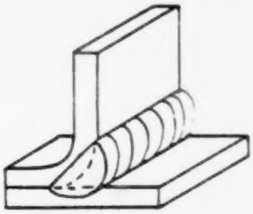
Section or End View



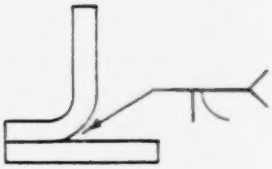
Elevation

Application of Flared Bevel-Groove Welding Symbol

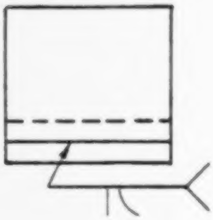
Arrow Side of Flared Bevel-Groove Welding Symbol



Desired Weld

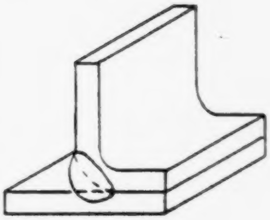


Section or End View

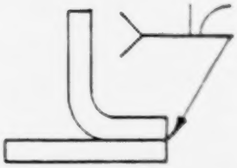


Elevation

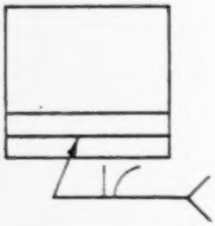
Other Side of Flared Bevel-Groove Welding Symbol



Desired Weld

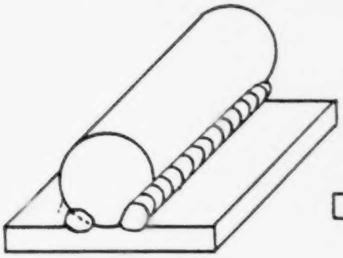


Section or End View

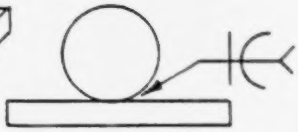


Elevation

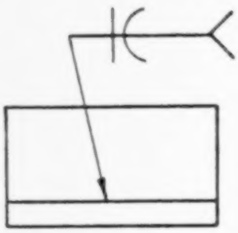
Both Sides of Flared Bevel-Groove Welding Symbol



Desired Weld



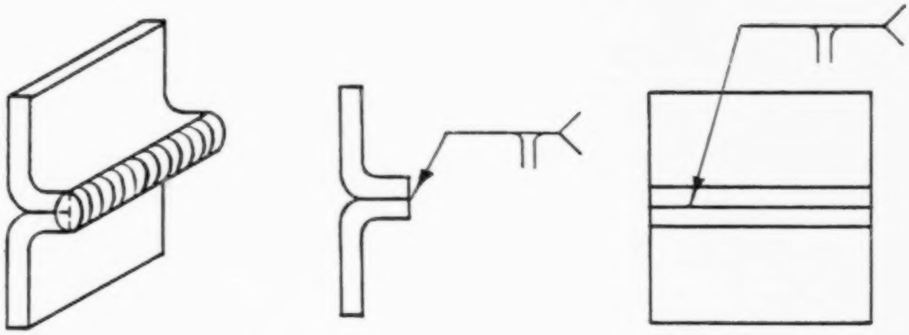
Section or End View



Elevation

Application of Edge-Flange Welding Symbol

Arrow Side of Edge-Flange Welding Symbol

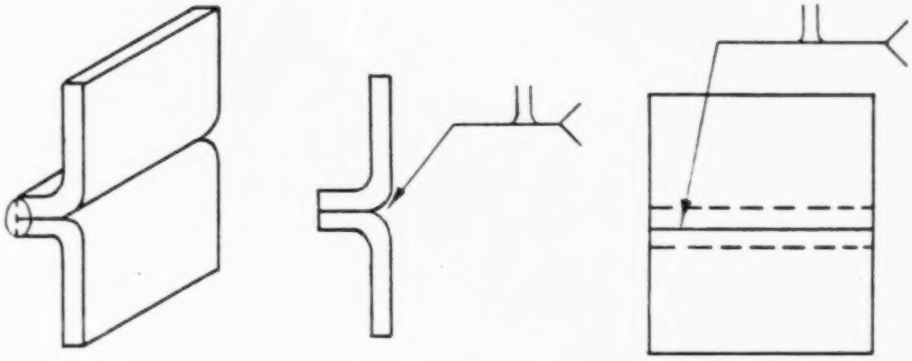


Desired Weld

Section or End View

Elevation

Other Side of Edge-Flange Welding Symbol



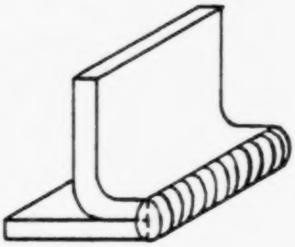
Desired Weld

Section or End View

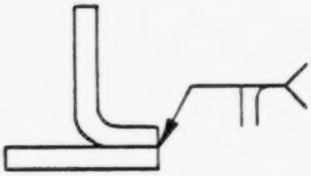
Elevation

Application of Corner-Flange Welding Symbol

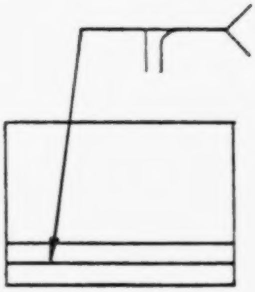
Arrow Side of Corner-Flange Welding Symbol



Desired Weld

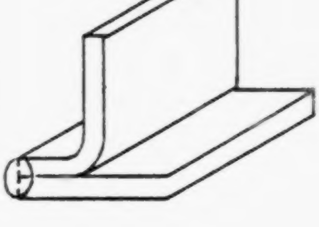


Section or End View

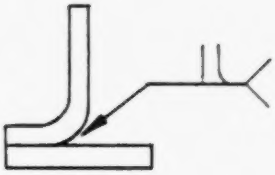


Elevation

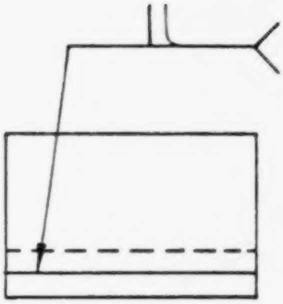
Other Side of Corner-Flange Welding Symbol



Desired Weld



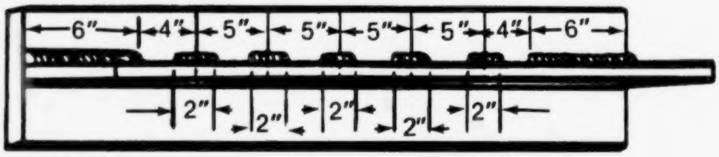
Section or End View



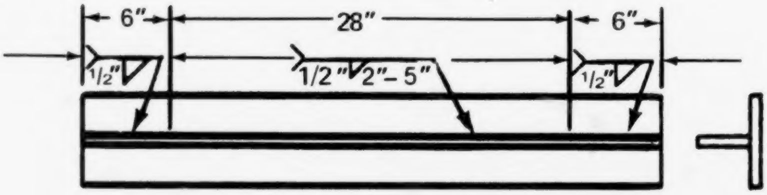
Elevation

Designation of Location and Extent of Fillet Welds

Combined Intermittent and Continuous Welding (One Side of Joint)

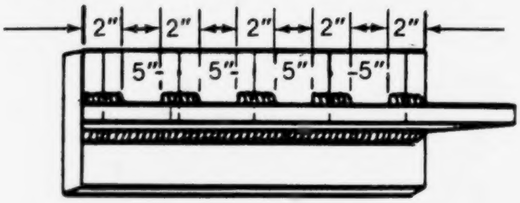

6"
4"
5"
5"
5"
5"
4"
6"
2"
2"
2"
2"
2"

Desired Welds

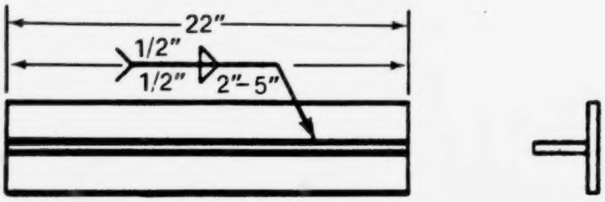

6"
28"
6"
1/2"
1/2" 2"– 5"
1/2"

Symbols

Combined Intermittent and Continuous Welding (Opposite Sides of Joint)



Desired Welds

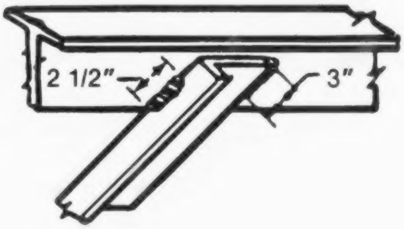


Symbols

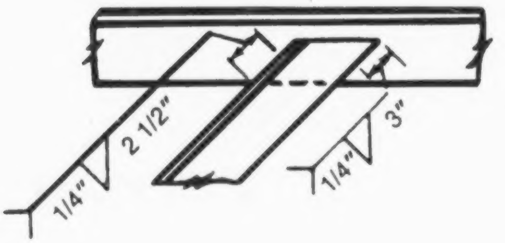
Designation of Location and Extent of Fillet Welds

(Continued)

Welds Definitely Located

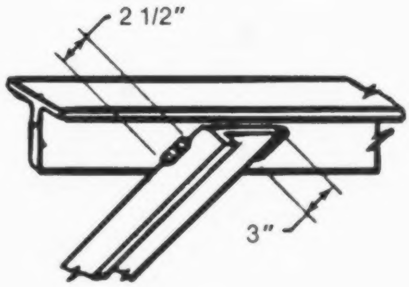


Desired Welds

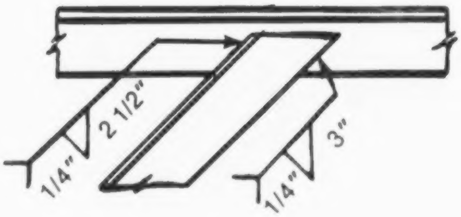


Symbols

Welds Approximately Located



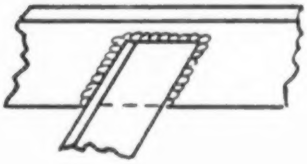
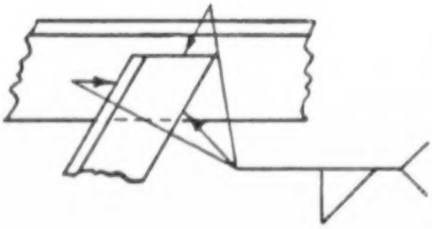
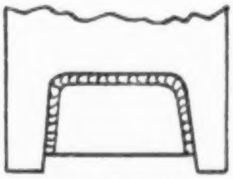
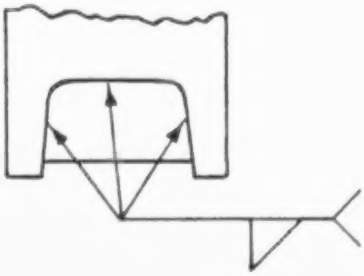
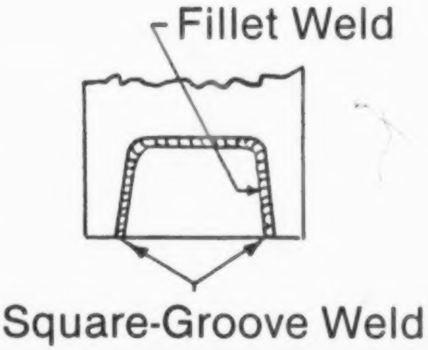
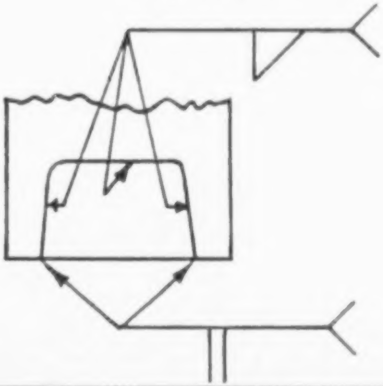
Desired Welds



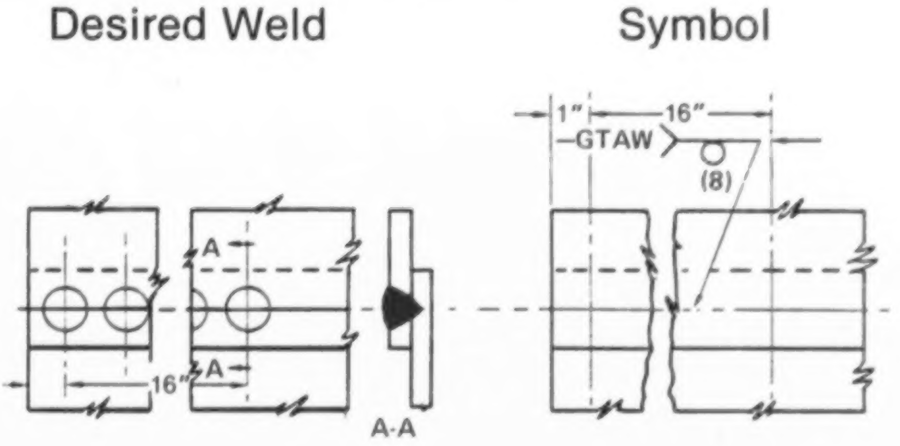
Symbols
(Welds May Be Placed Anywhere Along the Joint)

Designation of Extent of Welding

Weld with Abrupt Changes in Direction

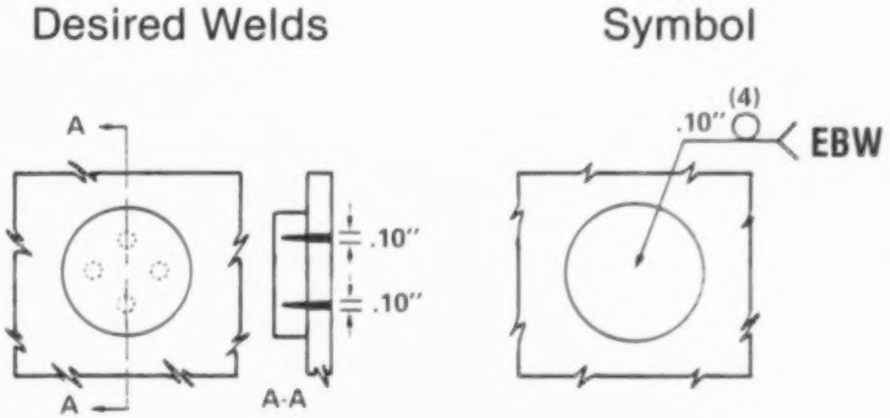
Desired Weld: 	Symbol 
Desired Weld:  Fillet Weld on Three Sides; No Weld at Corners	Symbol 
Desired Weld:  Fillet Weld Square-Groove Weld	Symbol 

Application of Dimensions to Spot Welding Symbols


Desired Weld
Symbol
A
A
16"
A-A
1"
16"
GTAW
(8)

Extent of Spot Welding

(Gas Tungsten-Arc Spot)

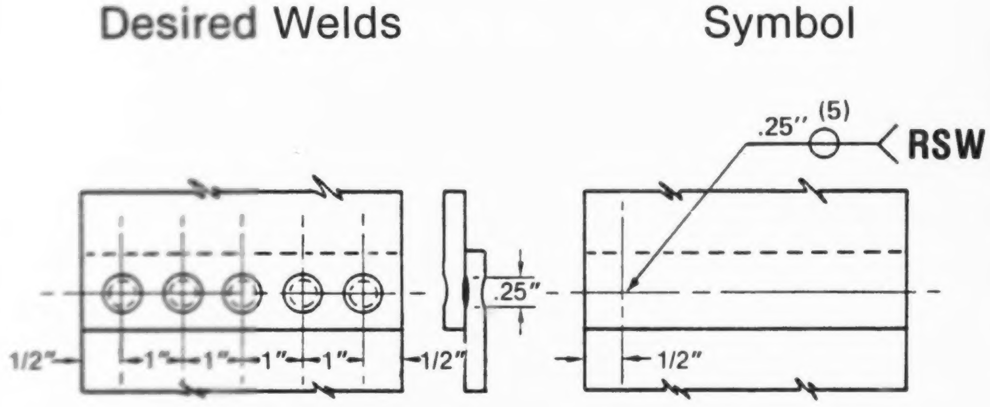

Desired Welds
Symbol
A
A
.10"
.10"
A-A
(4)
.10"
EBW

Specified Number of Spot Welds Located at Random

(Electron Beam Spot)

Application of Dimensions to Spot Welding Symbols

(Continued)


Desired Welds

Symbol
.25″
(5)
RSW
.25″
1/2″
1″
1″
1″
1″
1/2″
1/2″

Spot Welding Symbol Showing Use of Combined Dimensions

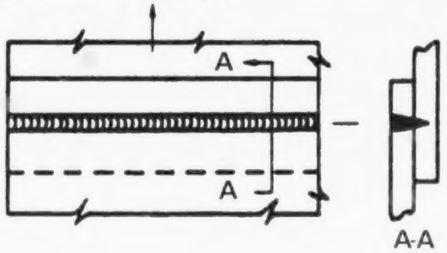
(Resistance Spot)

Application of Dimensions to Seam Welding Symbols

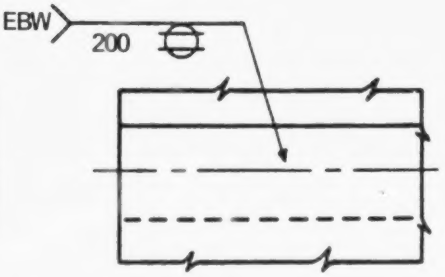
Strength of Seam Welds

(Electron Beam Seam)

Minimum Acceptable
Shear Strength
200 Lb/Lin. In.



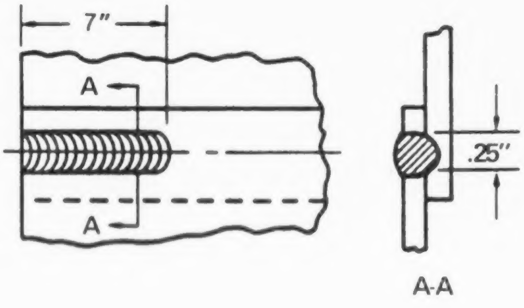
Desired Weld



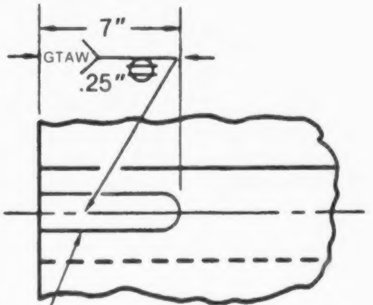
Symbol

Extent of Seam Welds

(Gas Tungsten-Arc Seam)



Desired Weld



Orientation as
Shown on Drawing

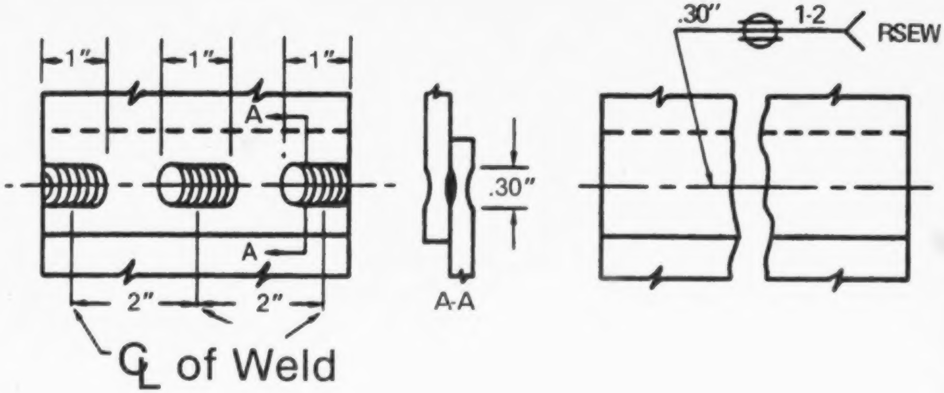
Symbol

Application of Dimensions to Seam Welding Symbols

(Continued)

Size, Length and Pitch of Intermittent Seam Welds

(Resistance Seam)


1"
1"
1"
A
A
.30"
A-A
2"
2"
℄ of Weld
.30"
1-2
RSEW

Desired Weld Symbol

ARC WELDING
UNIT II

INFORMATION SHEET

I. Terms and definitions

   A. Arc — Flow of current across a narrow gap, usually from tip of electrode to base metal

   B. Arc length — Distance from end of electrode to point where arc makes contact with work surface

   C. Arc welding — Joining of two or more pieces of metal by fusion process

   (NOTE: Arc welding is sometimes referred to as *shielded metal-arc welding, SMAW, or stick welding.*)

   D. Bevel — Angular cut made on the vertical edge of base metal to allow better weld penetration

   E. Butt joint — Weld between two metal joints on the same plane

   F. Crater — Depression at termination of weld

   G. Ductile — Capable of being drawn or stretched

   H. Electrode — Metal rod that conducts a current from electrode holder to base metal

   (NOTE: The metal rod melts and deposits metal in a bead.)

   I. Flux — Coating on outside of electrode; chemical used to promote fusion during welding process

   J. Fusion process — Process of heating metal to a molten state and allowing it to cool

   (NOTE: In arc welding, the heat is produced by the electric arc.)

   K. Gaseous shield — Gas given off by melting of electrode flux

   L. Heat line (heat-affected zone) — That part of base metal altered by heat from welding, brazing, or cutting operations

   M. Lead — Cables leading from ground clamp and holder to machine

   N. Low-hydrogen electrode — Electrode with low hydrogen content; used when cracking is a potential problem

INFORMATION SHEET

O. Malleable — Capable of being worked into a different shape or form

P. Pass — Single longitudinal progression of a welding operation along a joint or weld deposit

Q. Penetration — Distance from original surface of base metal to that point at which fusion ceases

R. Polarity — Condition of being positive (+) or negative (−), as the ends of a magnet or electrical mechanism

S. Puddle — Portion of a weld that is molten at the place heat is applied

T. Rippled — Lightly ruffled or covered with small waves

U. Slag inclusion — Nonmetallic porous material trapped in weld metal or between weld metal and base metal

V. Wire core — Metal center of electrode

II. Abbreviations associated with arc welding and their meanings

A. AC — Alternating current; electric current that reverses its direction at regular intervals

B. AWS — American Welding Society

C. DC — Direct current; electric current flowing in one direction only and mostly constant in value

D. OSHA — Occupational Safety and Health Act

E. psi — Pounds per square inch

III. Safety precautions to observe when welding

(NOTE: Observe OSHA safety rules.)

A. Do not look at arc or reflection without eye protection

B. Do not wear shield or helmet that is in bad condition

C. Do not chip slag without wearing safety goggles

D. Wear proper protective clothing

EXAMPLES: Welder's leather vest or jacket, long-sleeved shirt with collar and cuffs buttoned, leather gloves, high-topped shoes or boots

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  E. Do not strike an arc until you have taken all safety precautions

  F. Do not weld around combustible or flammable materials

  G. Do not pick up hot metals with bare hands

  H. Be sure that confined areas are properly ventilated

  I. Disconnect plug before checking welding machine

  J. Do not leave electrode holder on welding table or in direct contact with grounded metal

  K. Do not use worn or frayed cables

  L. Be sure that floor is dry; do not stand in water when welding

  M. Keep work area clean

  N. Deep tools and materials in proper locations

  O. Dispose of electrode stubs properly

IV. Types of arc-welding machines

  A. Alternating-current (AC) transformer welder

  (NOTE: The welding current reverses direction of flow 120 times per second.)

  B. Direct-current (DC) welder

  (NOTE: The welding current flows in one direction.)

  C. Motor generator

  (NOTE: The motor generator produces DC current.)

  D. Engine generator

  (NOTE: The engine generator can produce either AC or DC current.)

  E. AC/DC transformer rectifier

  (NOTE: This welder, which is supplied by an AC power source, can be switched to produce either AC or DC welding current.)

V. Common tools and equipment used in arc welding

  A. Welding machine

INFORMATION SHEET

B. Electrode holder with lead

C. Ground clamp with lead

D. Shield or helmet

E. Leather gloves

F. Chipping hammer

G. Safety goggles

H. Wire brush

I. Electrode

J. Protective clothing

K. Welding gauge

L. Temp-stick

VI. Terms and definitions associated with welding materials

A. Alloy — Mixture of two or more elements, of which at least one is a metal

B. Aluminum — Bluish silver-white, malleable, ductile, light, trivalent metallic element

C. Base metal — Metal to be cut or welded

D. Cast iron — Commercial alloy of iron, carbon, and silicon that is cast in a mold and is hard, brittle, nonmalleable, and incapable of being hammer-welded

E. Low-carbon steel — Steel containing 0.2 percent or less carbon

F. Mild steel — Steel containing from 0.2 to 0.5 percent carbon

G. Vanadium — Hardest known metal; used for making very strong alloy steels with manganese or chromium

VII. Types of electrodes

(NOTE: Electrodes most frequently used are made of mild steel.)

A. Mild steel

B. Low-alloy steel

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C. Nickel steel

D. Chromium/molybdenum steel

E. Manganese/molybdenum steel

F. Nickel/manganese/molybdenum steel

G. Nickel/molybdenum/vanadium steel

H. Aluminum

I. Copper aluminum (aluminum bronze)

J. Lead-bronze

K. Phosphor bronze

VIII. Common sizes of electrodes used in arc welding

(NOTE: Electrodes range in size from $^{1}/_{16}$ to $^{5}/_{8}$ inch.)

A. $^{3}/_{32}$ inch

B. $^{1}/_{8}$ inch

C. $^{5}/_{32}$ inch

D. $^{3}/_{16}$ inch

IX. Meanings of numbers in the AWS electrode classification system

EXAMPLE: E-6021

A. E — Electric arc welding

B. First two digits (60) — Minimum tensile strength deposited in thousands of pounds per square inch

C. Third digit (2) — Welding position

1. One — Indicates all positions
2. Two — Indicates flat and horizontal only
3. Three — Indicates flat only

D. Fourth or last digit (1) — Special characteristics and uses of the electrode (Table 2)

INFORMATION SHEET

EXAMPLE:

TABLE 2

Last-Digit Characteristics

Last Digit	Power Supply	Arc Action	Type of Flux	Penetration Characteristics
0	10, DCRP (+)	Digging	10, organic	10, deep
	20, AC or DC		20, mineral	20, medium
1	AC or DCRP (+)	Digging	Organic	Deep
2	AC or DC	Medium	Ductile	Medium
3	AC or DC	Soft	Ductile	Light
4	AC or DC	Soft	Ductile	Light
5	DCRP (+)	Medium	Low hydrogen	Medium
6	AC or DCRP (+)	Medium	Low hydrogen	Medium
7	AC or DC	Soft	Mineral	Medium
8	AC or DCRP (+)	Medium	Low hydrogen	Medium

(Source: T.B. Jefferson, *The Welding Encyclopedia*, p. E-4, Monticello Books, Lake Zurich, Illinois, 1968.)

X. Reverse and straight polarity

A. Reverse (+) — Current flows from base metal to electrode

B. Straight (−) — Current flows from electrode to base metal

(NOTE: Welding leads must connect to correct terminals if the machine has a polarity switch. Otherwise, a change in polarity is made by reversing leads on the terminals.)

XI. Factors that determine correct polarities to use

A. Electrode

B. Type of flux on electrode

(NOTE: Use *Electrode Guidebook* to determine correct polarity for different electrodes.)

EXAMPLES: E-6010 (+) reverse polarity
E-6012 AC-DCSP (−) straight polarity
E-7018 AC-DCRP (+) reverse polarity
E-7024 AC-DCRP-SP (−) reverse or straight polarity

XII. Purposes of electrode flux

A. Stabilizing arc

B. Shielding molten puddle from air

C. Floating impurities out of puddle

D. Forming slag and slowing down cooling

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- E. Increasing welding speed
- F. Improving quality of weld
- G. Adding alloying elements to weld metal

XIII. Factors to consider when selecting electrodes

- A. Plans and specifications
- B. Physical and chemical properties of base metal
- C. Composition of base metal
- D. Thickness and shape of base metal
- E. Welding position
- F. Welding current
- G. Joint design and fit-up
- H. Production efficiency and job conditions

XIV. Effects of raising and lowering welding machine amperes

- A. Rising amperes — Produces more heat; increases penetration
- B. Lowering amperes — Produces less heat; decreases penetration

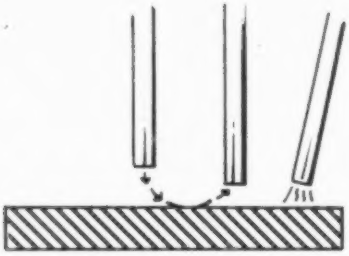
XV. Methods of striking an arc (Figures 1 and 2)

- A. Scratching

  (NOTE: The scratching method is similar to striking a match.)

  EXAMPLE:

FIGURE 1a

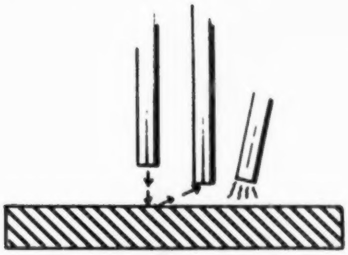


INFORMATION SHEET

B. Tapping

EXAMPLE:

FIGURE 1b



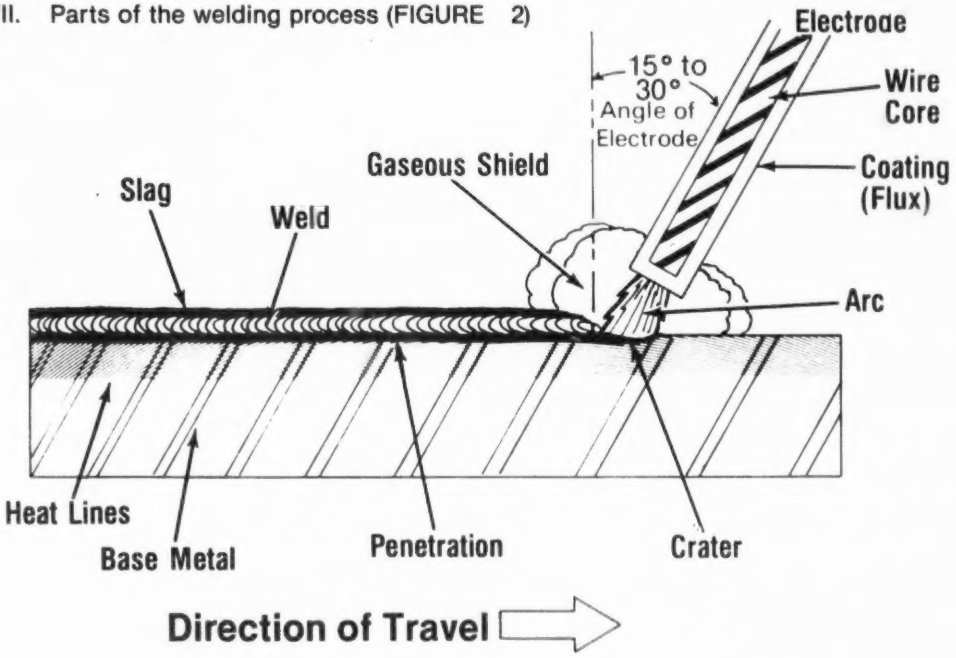
XVI. Characteristics of proper arc length

A. End of electrode same distance from base metal as diameter of electrode

EXAMPLE: When using 1/8-inch electrode, arc length should be 1/8 inch.

B. Arc length making steady hum at welder and frying sound at arc

XVII. Parts of the welding process (FIGURE 2)


Electroae
15° to 30°
Angle of Electrode
Wire Core
Coating (Flux)
Gaseous Shield
Slag
Weld
Arc
Heat Lines
Base Metal
Penetration
Crater
Direction of Travel

INFORMATION SHEET

XVIII. Descriptions of types of welds

A. Bead weld — Weld made by one pass of electrode

B. Fillet weld — Weld made in corner or angle formed by two pieces of metal with welded surfaces at approximately 90-degree angles to each other

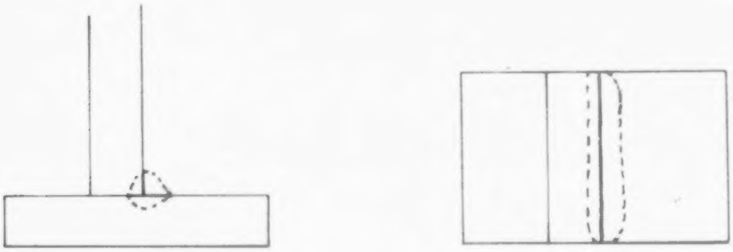
C. Groove weld — Weld made in groove formed by two beveled pieces of metal

D. Tack weld — Temporary weld made to hold parts in alignment until final welds are made

XIX. Types of welds (Figures 3-5)

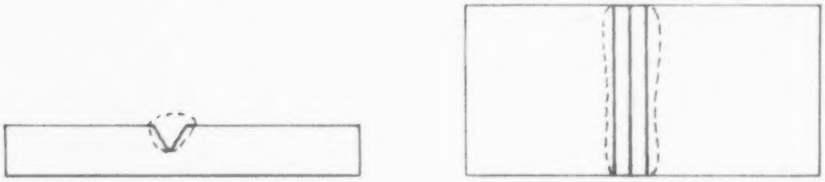
A. Fillet

FIGURE 3



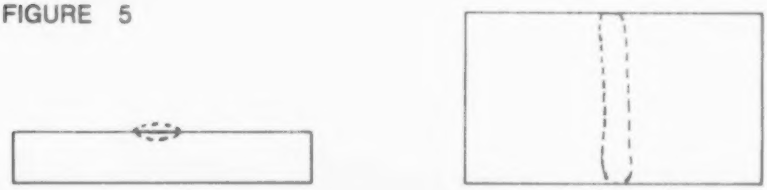
B. Groove

FIGURE 4



C. Bead

FIGURE 5

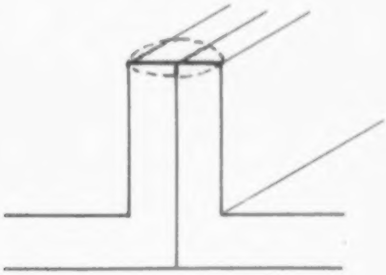


INFORMATION SHEET

XX. Types of weld joints (Figures 6-10)

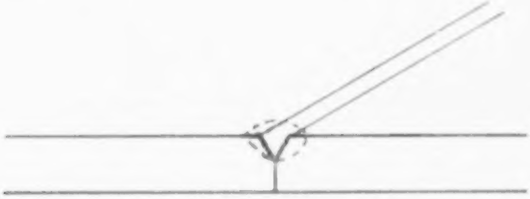
A. Edge

FIGURE 6



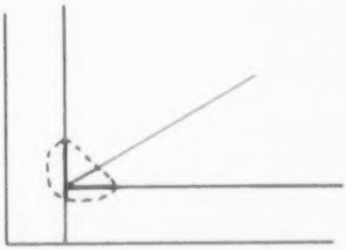
B. Butt

FIGURE 7



C. Corner

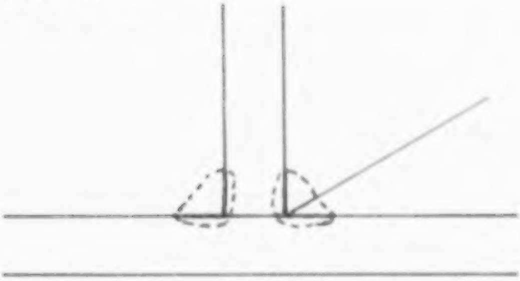
FIGURE 8



INFORMATION SHEET

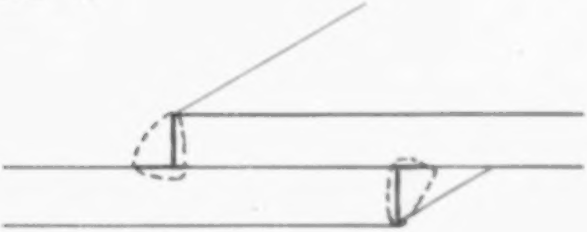
D. T

FIGURE 9



E. Lap

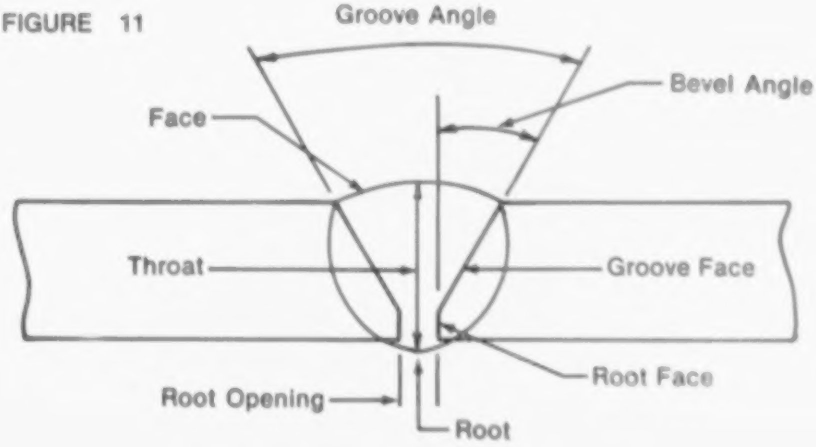
FIGURE 10



XXI. Parts of groove and fillet welds (Figures 11 and 12)

A. Groove

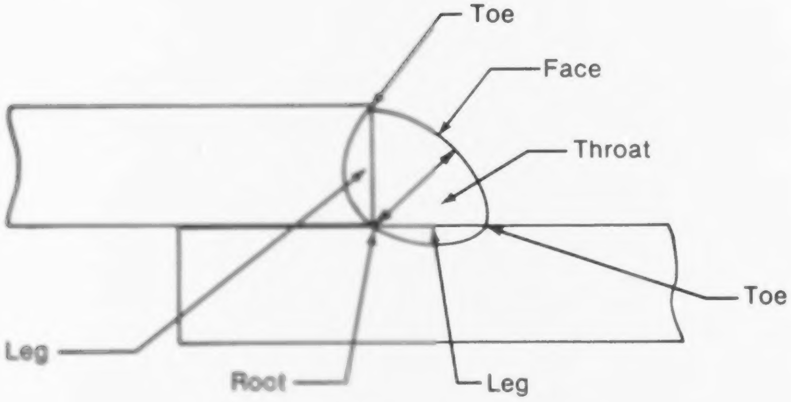
FIGURE 11


Groove Angle
Bevel Angle
Face
Throat
Groove Face
Root Face
Root Opening
Root

INFORMATION SHEET

B. Fillet

FIGURE 12



XXII. Positions used in arc welding

A. Flat

B. Horizontal

C. Vertical

(NOTE: In vertical position, the bead may be started either from top or bottom, depending on characteristics of metal and plans and specifications.)

D. Overhead

XXIII. Reasons for poor welds

A. Incorrect machine adjustment

B. Too large or too small electrode

C. Improper movement of electrode

(NOTE: You must consider rate of travel and pattern of movement of the electrode.)

D. Improper angle of electrode

E. Improper preparation of base metal

F. Incorrect arc length

INFORMATION SHEET

XXIV. Types of electrode motions (rod manipulations) (See Figures 13-15.)

(NOTE: On a single-layer weld, to ensure proper fusion in the root zone, the arc may progress with a straight, forward motion or an oscillating motion, depending on size of joint to be filled.)

A. Small oscillating motion

B. Small circular motion

C. Back-and-forth motion with half circle

D. Figure-eight motion

E. Triangular motion

(NOTE: Most operators use all of these motions, depending upon type of seam, type of joint, size of weld, and position of weld.)

EXAMPLES:

FIGURE 13

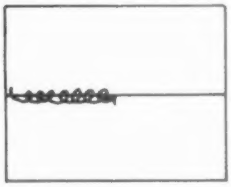


FIGURE 14

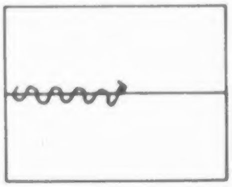
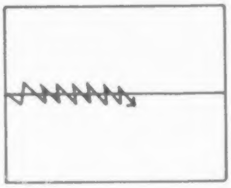


FIGURE 15



XXV. Characteristics of a good weld

A. Smooth edges

B. Correct bead size

C. Even penetration (well fused)

D. Even ripple

E. Clean, bright weld

F. Slight crown

INFORMATION SHEET

XXVI. Elements of welding symbols and their descriptions

(NOTE: The term *weld symbol* indicates the type of weld. The term *welding symbol* includes type of weld and other information.)

A. Reference line

1. Top — Contains information for weld on side opposite arrow
2. Bottom — Contains information for weld on arrow side

B. Arrow — Points toward joint

C. Basic weld symbols — Indicate type of weld

D. Dimensions and other data — Indicate size, length of weld; shown on same side of reference line as weld symbol

E. Supplementary symbols — Indicate contour, backing or spacer material, melt-through, field weld, weld all around

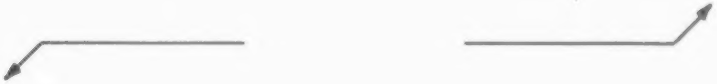
F. Finish symbols — Indicate method of finish

G. Tail — Includes specification, process, or other reference (Figure 16)

(NOTE: The welding symbol does not have a tail if there is not a specification, process, or other reference.)

EXAMPLES:

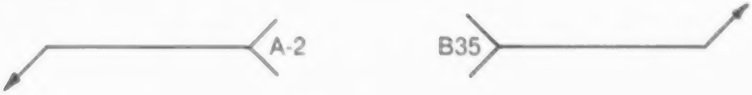
FIGURE 16



H. Specification, process, or other reference — Details information pertinent to weld; shown inside tail (Figure 17)

EXAMPLES:

FIGURE 17



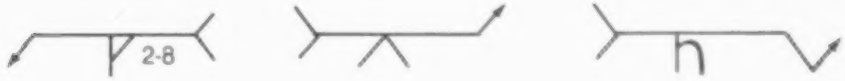
INFORMATION SHEET

XXVII. Symbols showing location of weld (Figures 18-20)

A. Weld on arrow side of joint — Shown by placing weld symbol beneath reference line

EXAMPLES:

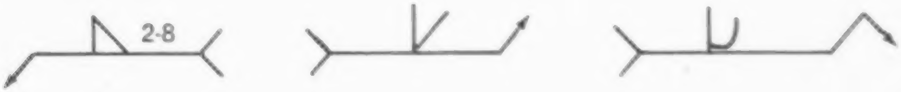
FIGURE 18



B. Weld on other side of joint — Shown by placing weld symbol on top of reference line

EXAMPLES:

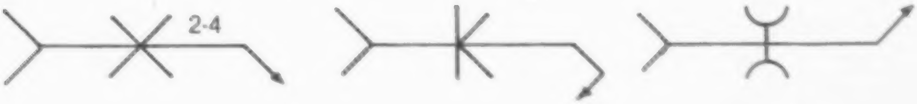
FIGURE 19



C. Weld on both sides of joint — Shown by placing weld symbols on both sides of reference line

EXAMPLES:

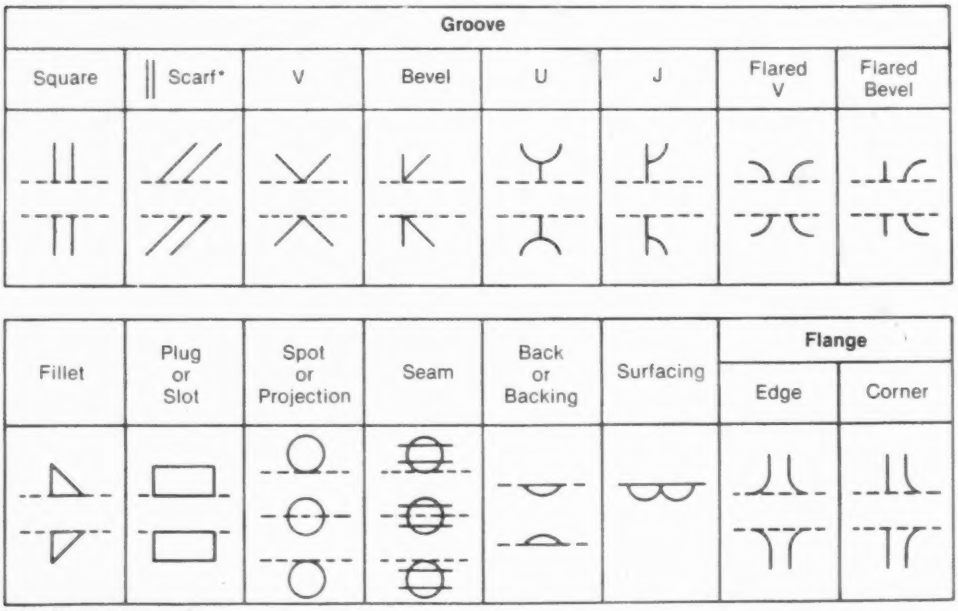
FIGURE 20



INFORMATION SHEET

XXVIII. Basic weld symbols (Figure 21)

FIGURE 21


Groove
Square
Scarf*
V
Bevel
U
J
Flared V
Flared Bevel
Fillet
Plug or Slot
Spot or Projection
Seam
Back or Backing
Surfacing
Flange
Edge
Corner

*Used for brazed joints only

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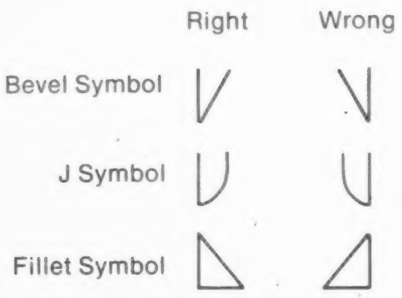
XXIX. Correct and incorrect drawing of symbols with one vertical side

(NOTE: Draw symbols that have one vertical side with that side always on the left. See Figure 22.)

EXAMPLES: Fillet, bevel and J-groove, flared bevel-groove, and corner-flange weld symbols

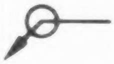
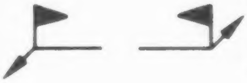
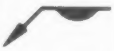
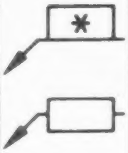
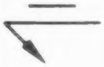
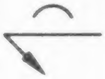
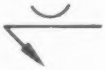
FIGURE 22


Right
Wrong
Bevel Symbol
J Symbol
Fillet Symbol

INFORMATION SHEET

XXX. Supplementary symbols (Figure 23)

FIGURE 23

Weld All Around	Field Weld	Melt-Through	‖ Backing or Spacer Material	**Contour**		
				ǀ Flush	Convex	Concave
						

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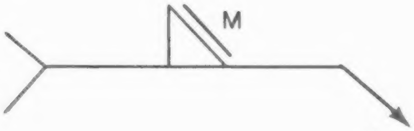
XXXI. Finish symbols used with contour symbols (Figures 24-28)

(NOTE: Finishing of welds, other than cleaning, is indicated by appropriate contour and finish symbols. These symbols indicate the method, not the degree, of finish.)

A. M — Machined

EXAMPLE:

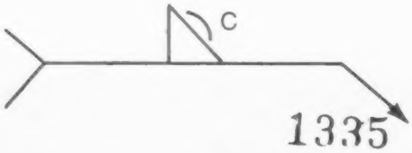
FIGURE 24



B. C — Chipped

EXAMPLE:

FIGURE 25

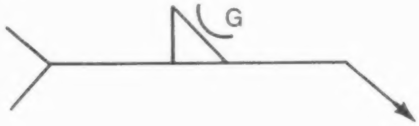


INFORMATION SHEET

C. G — Ground

EXAMPLE:

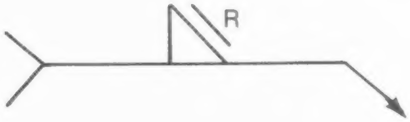
FIGURE 26



D. R — Rolled

EXAMPLE:

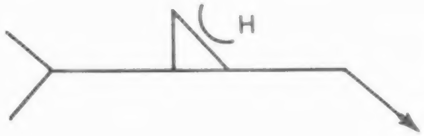
FIGURE 27



E. H — Hammered

EXAMPLE:

FIGURE 28



ARC WELDING
UNIT II

JOB SHEET #1 — START, STOP, AND RESTART A BEAD

I. Equipment and materials

  A. Piece of metal, 4 inches square, ¼- to ⅜-inch thick

  B. Welding machine

  C. Electrode holder with lead

  D. Ground clamp with lead

  E. Shield or helmet

  F. Leather gloves

  G. Electrodes

  H. Wire brush

  I. Protective clothing

II. Procedure

  A. Prepare metal for welding

  B. Put on shield or helmet

  C. Strike arc 1 inch from edge where bead is to begin (Figures 29 and 30)

FIGURE 29

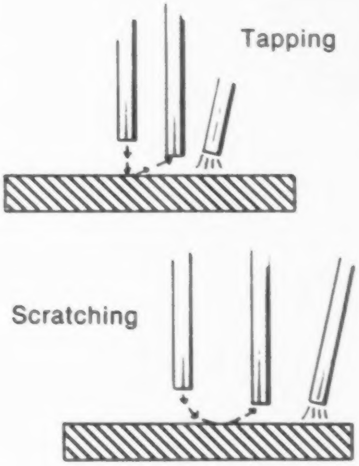
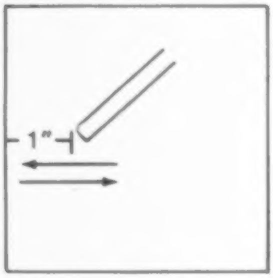


FIGURE 30



JOB SHEET #1

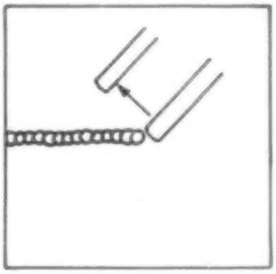
D. When arc burns brightly, move to edge, maintaining correct arc length; begin forming puddle

E. Move across metal 2 inches

F. Move electrode back through puddle, and lift up to stop bead (Figure 31)

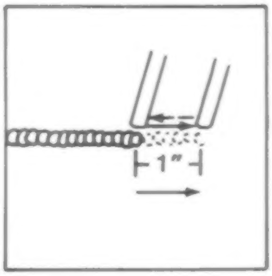
(NOTE: Moving electrode through puddle will prevent cracks from forming in the puddle.)

FIGURE 31



G. Strike arc about 1 inch in front of crater to restart (Figure 32)

FIGURE 32



H. When arc burns brightly, move back through crater, and continue the bead

(NOTE: Moving back through the crater is necessary in order for beads to blend with one another without a change in continuity.)

I. Clean work area; put away all equipment and materials

ARC WELDING
UNIT II

JOB SHEET #2 — CONSTRUCT A PAD WELD

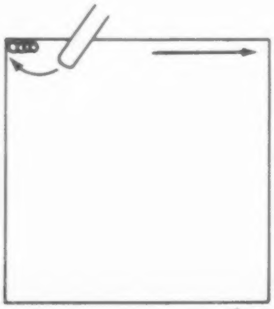
I. Equipment and materials

- A. Piece of metal, 4 inches square, $\frac{1}{4}$- to $\frac{3}{8}$-inch thick
- B. Welding machine
- C. Electrode holder with lead
- D. Ground clamp with lead
- E. Shield or helmet
- F. Leather gloves
- G. Electrodes
- H. Safety goggles
- I. Chipping hammer
- J. Wire brush
- K. Protective clothing

II. Procedure

- A. Prepare metal for welding
- B. Put on shield or helmet
- C. Strike arc, and move to point to begin pad (Figure 33)

FIGURE 23



JOB SHEET #2

D. Lay a straight bead across the plate, using an oscillating motion

(NOTE: When using an E-6011 electrode, you must manipulate the rod to run a bead. Ask your instructor to explain this process.)

E. Hold electrode at a 15- to 30-degree angle in direction of travel; to maintain correct arc length, lower electrode as rod burns away (Figure 34)

(NOTE: There should be 90 degrees on each side of the electrode. See Figure 35.)

FIGURE 34

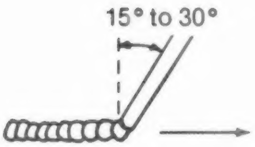
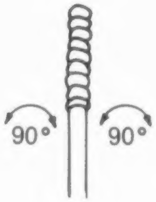


FIGURE 35



F. Move electrode steadily from left to right across pad

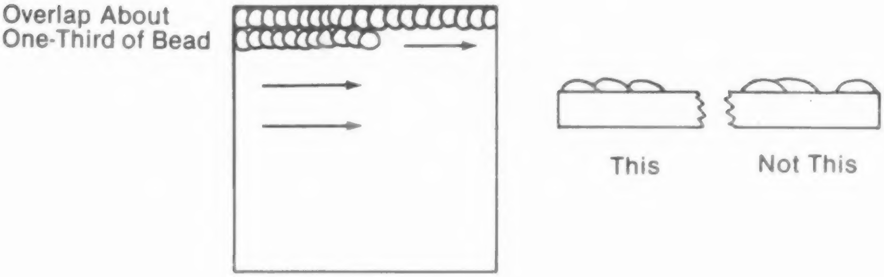
G. Clean slag from each bead before starting next one

CAUTION

If you remove your shield or helmet, always be sure to put on safety goggles.

H. Run beads, overlapping each bead until pad is full (Figure 36)

FIGURE 36



I. Before chipping, let each bead cool until slag is black

J. Run additional bead layers until desired thickness is obtained

K. Clean work area; put away all equipment and materials

ARC WELDING
UNIT II

JOB SHEET #3 — CONSTRUCT A BUTT WELD

I. Equipment and materials

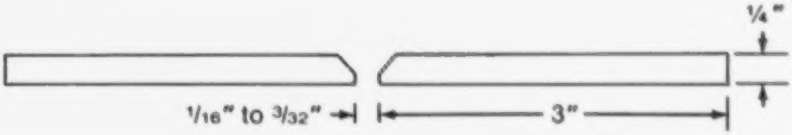
- A. Two metal pieces, 3 by 6 inches, 1/4- to 3/8-inch thick
- B. Welding machine
- C. Electrode holder with lead
- D. Ground clamp with lead
- E. Shield or helmet
- F. Leather gloves
- G. Electrodes
- H. Safety goggles
- I. Chipping hammer
- J. Wire brush
- K. Protective clothing

II. Procedure

- A. Prepare metal to be welded

  (NOTE: If metal thickness is over 1/8 inch, the edges should be beveled. See Figure 37.)

FIGURE 37



- B. Place two pieces of metal parallel to each other

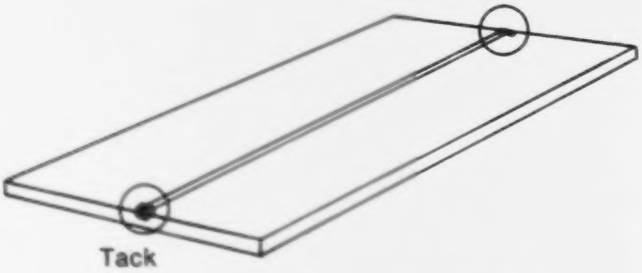
  (NOTE: Leave a space of 1/16 to 3/32 inch between them.)

JOB SHEET 3

C. Put on shield or helmet

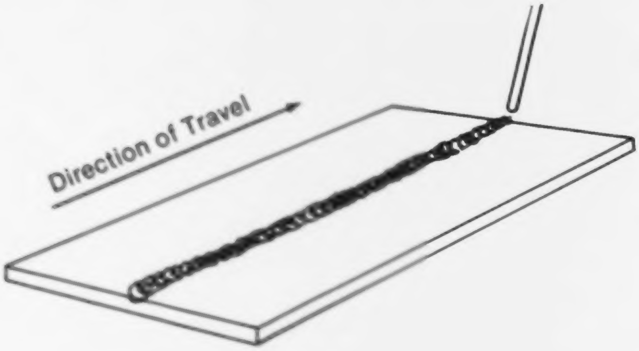
D. Strike an arc, and tack-weld pieces together at both ends (Figure 38)

FIGURE 38



E. Complete weld using a single pass (Figure 39)

FIGURE 39



F. Chip slag; brush the weld

CAUTION

If you remove your shield or helmet, always be sure to put on safety goggles.

G. Clean work area; put away all equipment and materials

ARC WELDING
UNIT II

JOB SHEET #4 — CONSTRUCT A LAP-JOINT FILLET WELD IN THE OVERHEAD POSITION

I. Equipment and materials

  A. Arc-welding station and required tools

  B. Two pieces mild-steel plate, 2 by 6 inches, 1/4- to 3/8-inch thick

  C. Electrode E-6010, 1/8- or 5/32-inch

    1. 1/8-inch — 75 to 130 amperes

    2. 5/32-inch — 90 to 175 amperes

  D. Current DCRP + at electrode

  E. Chipping hammer

  F. Wire brush

  G. Leather gloves

  H. Shield or helmet

  I. Protective clothing

II. Procedure

  A. Adjust welding machine to correct current and amperage setting

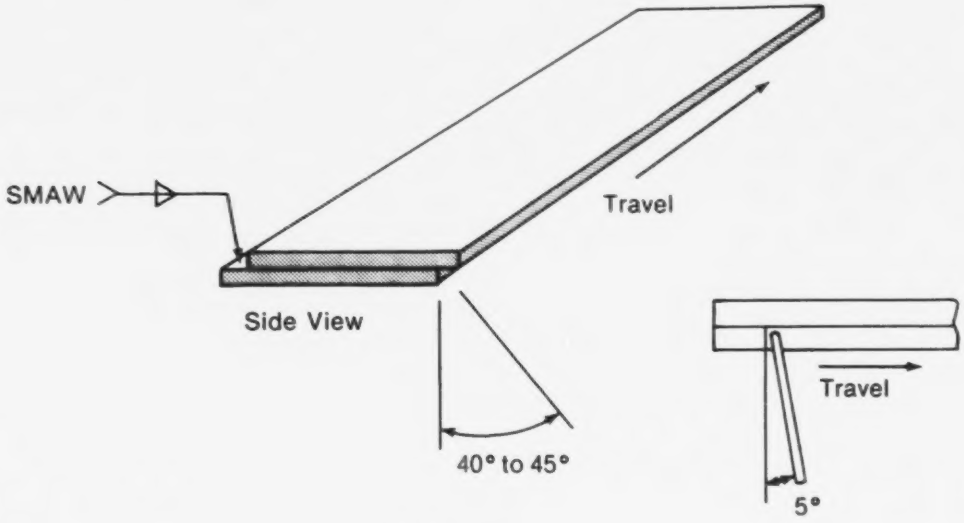
  B. Put on shield or helmet

  C. Prepare metal, and tack plate together for a 90-degree lap joint in the overhead position

JOB SHEET #4

D. Position electrode 40 to 45 degrees out from vertical and inclined 5 degrees in direction of travel (Figure 40)

FIGURE 40



E. Strike arc, and establish a puddle evenly on both pieces

(NOTE: Be sure to get good penetration into root of joint without undercutting or overlapping plates. Some form of whipping motion will be needed.)

F. After depositing first bead (root pass), the weld should be chipped, brushed clean, and checked for bead appearance

G. Deposit additional beads if necessary as stringers or weaves

H. Clean plates

I. Clean work area; put away all equipment and materials

ARC WELDING
UNIT II

JOB SHEET #5 — CONSTRUCT A T-JOINT WELD IN THE VERTICAL UP POSITION

I. Equipment and materials

  A. Arc-welding station and required tools

  B. Two pieces mild-steel plate, 2 by 6 inches, $^1/_4$- to $^3/_8$-inch thick

  C. Electrode E-6010, $^1/_8$- or $^5/_{32}$-inch

    1. $^1/_8$-inch — 75 to 130 amperes

    2. $^5/_{32}$-inch — 90 to 175 amperes

  D. Current DCRP + at electrode

  E. Chipping hammer

  F. Wire brush

  G. Leather gloves

  H. Shield or helmet

  I. Protective clothing

II. Procedure

  A. Adjust welding machine to correct current and amperage setting

  B. Put on shield or helmet

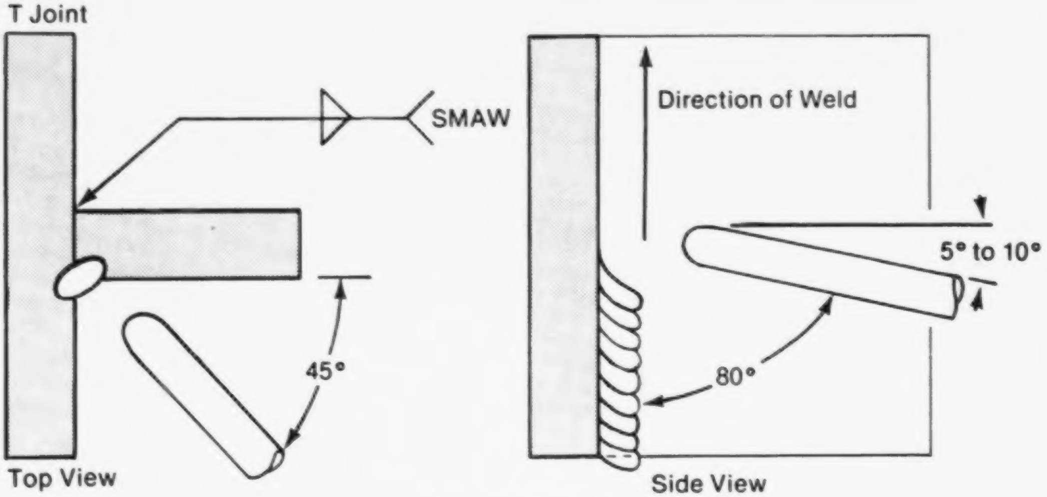
  C. Prepare metal, and tack in vertical position; remove slag

  D. Strike arc at bottom of joint; hold a high arc for length of one to two seconds to heat plates

JOB SHEET #5

E. Position electrode in middle of joint, making a 45-degree angle with each plate and holding electrode 5 to 10 degrees down from horizontal (Figure 41)

FIGURE 41



Electrode Position of Vertical Up T-Joint

F. Deposit weld upward using some form of up and down whipping motion

(NOTE: Bead uniformity depends upon proper timing and manipulation of electrode. Check with instructor for correct procedures.)

G. Remove slag and clean thoroughly after each pass

H. Alternate sides to minimize distortion

(NOTE: Check with instructor at this point. Upon receiving instructor's approval, additional beads may be stringers or some form of weave bead.)

I. Clean work area; put away all equipment and materials

ARC WELDING
UNIT II

JOB SHEET #6 — CONSTRUCT A SQUARE-GROOVE BUTT-JOINT WELD IN THE VERTICAL DOWN POSITION

I. Equipment and materials

- A. Arc-welding station and required tools
- B. Two pieces mild-steel plate, 3 by 6 inches, 1/8- to 3/16-inch thick
- C. Electrode E-6010, 1/8- or 5/32-inch
  - 1. 1/8-inch — 75 to 130 amperes
  - 2. 5/32-inch — 90 to 175 amperes
- D. Current DCRP + at electrode
- E. Chipping hammer
- F. Wire brush
- G. Leather gloves
- H. Shield or helmet
- I. Protective clothing

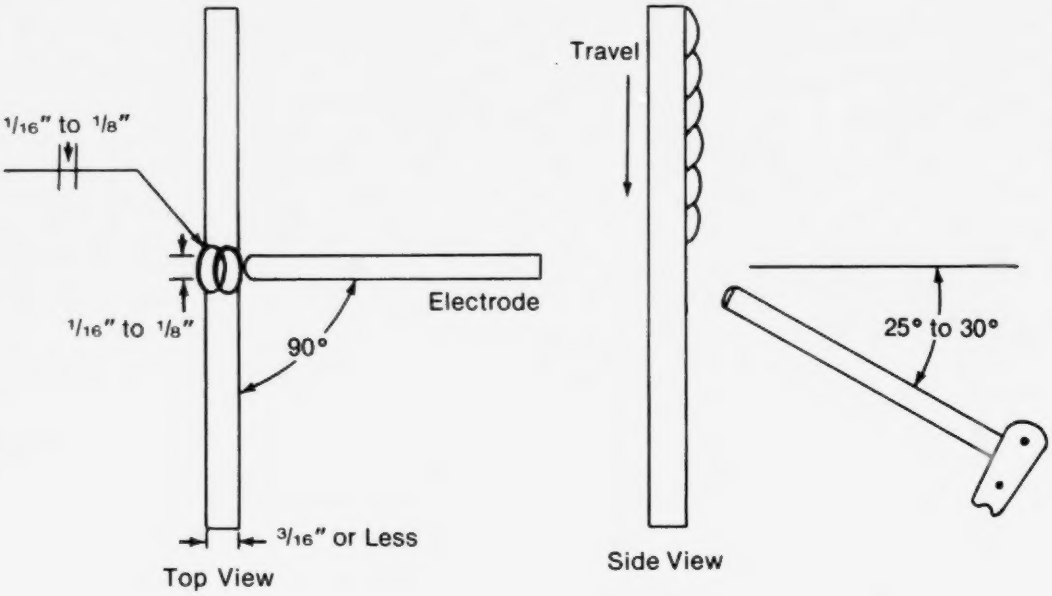
II. Procedure

- A. Adjust welding machine to correct current and amperage setting
- B. Put on shield or helmet
- C. Prepare metal and tack, leaving a 1/16- to 1/8-inch root gap in vertical position

JOB SHEET #6

D. Position electrode in middle of joint and down 25 to 30 degrees from horizontal (Figure 42)

FIGURE 42


1/16" to 1/8"
1/16" to 1/8"
90°
Electrode
3/16" or Less
Top View
Travel
25° to 30°
Side View

E. Strike arc at top of plates; hold a high arc length for one or two seconds to heat plates and prevent cold laps

F. Weld down, holding a short arc length and using some form of whipping motion

G. Remove all slag from face and root; inspect bead thoroughly for penetration and even fusion with both plates

H. Start at top of reverse side and run second bead using same technique as in the first pass

I. Clean work area; put away all equipment and materials

ARC WELDING
UNIT II

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with arc welding to their correct definitions. Write the correct numbers in the blanks. Terms and definitions are continued on the following page.

______a. Flow of current across a narrow gap, usually from tip of electrode to base metal

______b. Process of heating metal to a molten state and allowing it to cool

______c. Joining of two or more pieces of metal by fusion process

______d. Depression at termination of weld

______e. Single longitudinal progression of a welding operation along a joint or weld deposit

______f. Metal rod that conducts a current from electrode holder to base metal

______g. Angular cut made on the vertical edge of base metal to allow better weld penetration

______h. Weld between two metal joints on the same plane

______i. Portion of a weld that is molten at the place heat is applied

______j. Metal center of electrode

______k. Cables leading from ground clamp and holder to machine

______l. Coating on outside of electrode; chemical used to promote fusion during welding process

______m. Gas given off by melting of electrode flux

1. Arc welding
2. Bevel
3. Puddle
4. Crater
5. Wire core
6. Arc
7. Pass
8. Butt joint
9. Fusion process
10. Electrode
11. Flux
12. Lead
13. Gaseous shield

TEST

_____n. Nonmetallic porous material trapped in weld metal or between weld metal and base metal

_____o. That part of base metal altered by heat from welding, brazing, or cutting operations

_____p. Distance from original surface of base metal to that point at which fusion ceases

_____q. Electrode with low hydrogen content; used when cracking is potential problem

_____r. Capable of being drawn or stretched

_____s. Distance from end of electrode to point where arc makes contact with work surface

_____t. Lightly ruffled or covered with small waves

_____u. Capable of being worked into a different shape or form

_____v. Condition of being positive (+) or negative (−), as the ends of a magnet or electrical mechanism

14. Heat line (heat-affected zone)
15. Penetration
16. Low-hydrogen electrode
17. Slag inclusion
18. Rippled
19. Malleable
20. Arc length
21. Ductile
22. Polarity

2. Write meanings of abbreviations associated with arc welding.

a. AC — ____

____

b. AWS — ____

____

c. DC — ____

____

d. OSHA — ____

____

e. psi — ____

____

TEST

3. State ten safety precautions to observe when welding.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

j. ______________________________

4. Name types of arc-welding machines.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

5. Select from the following list common tools and equipment used in arc welding. Write an "X" in the blank before each correct answer.

_____a. Shield or helmet

_____b. Safety goggles

_____c. Electrode

_____d. Oxyacetylene tank

_____e. Ground clamp with lead

_____f. Welding machine

TEST

______g. Welding rod

______h. Electrode holder with lead

______i. Leather gloves

______j. Tip cleaner

______k. Protective clothing

6. Match to their correct definitions terms associated with welding materials. Write the correct numbers in the blanks.

______a. Steel containing from 0.2 to 0.5 percent carbon

______b. Metal to be cut or welded

______c. Steel containing 0.2 percent or less carbon

______d. Hardest known metal; used for making very strong alloy steels with manganese or chromium

______e. Commercial alloy of iron, carbon, and silicon that is cast in a mold and is hard, brittle, nonmalleable, and incapable of being hammer-welded

______f. Bluish silver-white, malleable, ductile, light, trivalent metallic element

______g. Mixture of two or more elements, of which at least one is a metal

1. Alloy
2. Aluminum
3. Base metal
4. Cast iron
5. Low-carbon steel
6. Mild steel
7. Vanadium

7. List three types of electrodes.

a. ______________________________

b. ______________________________

c. ______________________________

8. Select from the following list common sizes of electrodes used in arc welding. Write an "X" in the blank before each correct answer.

______a. $^{3}/_{32}$ inch

______b. $^{1}/_{8}$ inch

______c. $^{1}/_{4}$ inch

TEST

_____d. 5/16 inch

_____e. 5/32 inch

_____f. 3/16 inch

9. Interpret meanings of numbers in the AWS electrode classification system.

EXAMPLE: E-6021

a. E — ______________________________

b. First two digits — ______________________________

____

c. Third digit — ______________________________

1) ______________________________

2) ______________________________

3) ______________________________

d. Fourth or last digit — ______________________________

____

10. Distinguish between reverse and straight polarity. Write an "X" in the blank before the statement that represents reverse polarity.

_____a. Current flows from electrode to base metal

_____b. Current flows from base metal to electrode

11. Select from the following list factors that determine correct polarities to use. Write an "X" in the blank before each correct answer.

_____a. Electrode

_____b. Current

_____c. Type of flux on electrode

_____d. Color of electrode

_____e. Brand of electrode

TEST

12. Select from the following list purposes of electrode flux. Write an "X" in the blank before each correct answer.

_____a. Floating impurities out of puddle

_____b. Protecting electrode

_____c. Forming slag and slowing down cooling

_____d. Increasing welding speed

_____e. Shielding electrode from air

_____f. Stabilizing arc

_____g. Adding slag elements to weld metal

_____h. Improving quality of weld

13. List five factors to consider when selecting electrodes.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

14. Describe effects of raising and lowering welding machine amperes.

a. Raising amperes — ______________________________

____

b. Lowering amperes — ______________________________

____

15. Name methods of striking an arc.

a. ______________________________

b. ______________________________

TEST

16. Select from the following list characteristics of proper arc length. Write an "X" in the blank before each correct answer.

______a. Arc length same size as bead

______b. Arc length making steady hum at welder and frying sound at arc

______c. End of electrode same distance from base metal as diameter of electrode

______d. End of electrode touching base metal

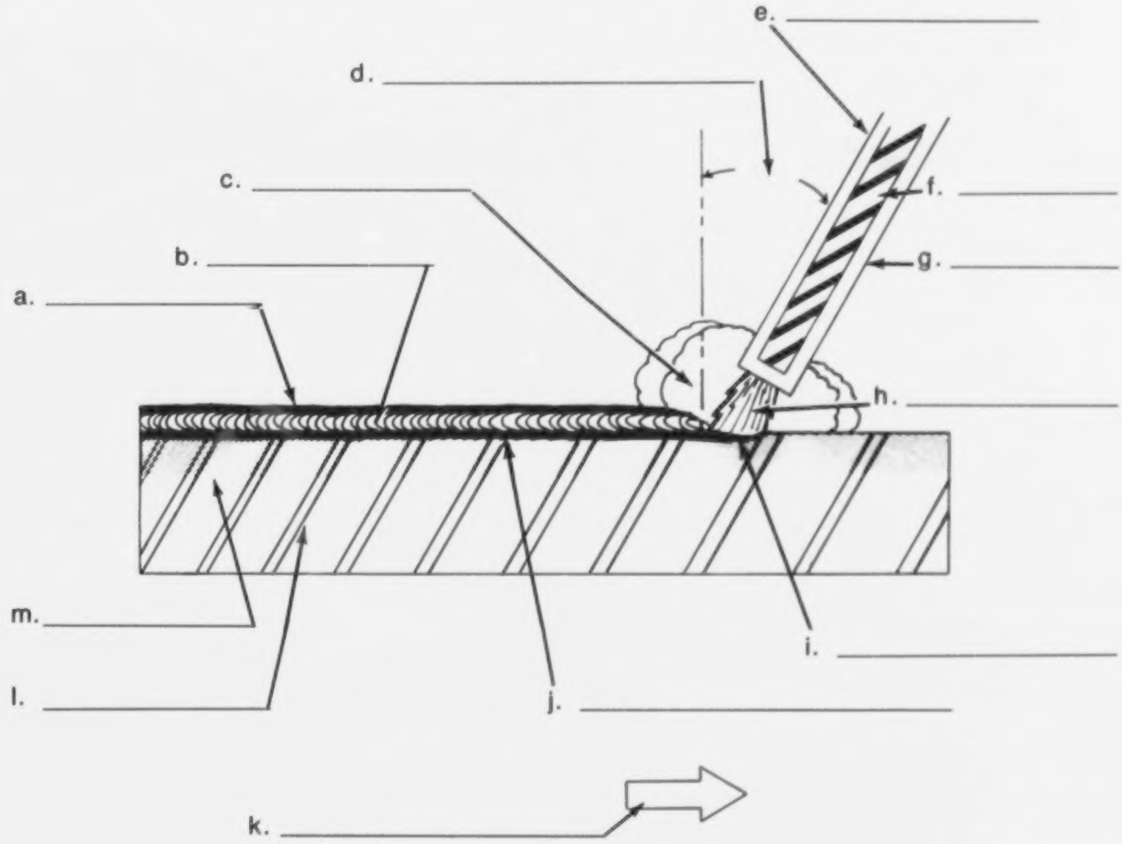
17. Identify parts of the welding process illustrated below. Write the correct names in the blanks.

Electrode
Coating (flux)
Penetration
Slag

Wire core
Arc
Weld
Direction of travel

Angle of electrode 15 to 30 degrees
Heat lines
Gaseous shield

Base metal
Crater



TEST

18. Match types of welds to their correct descriptions. Write the correct numbers in the blanks.

_____a. Weld made by one pass of electrode

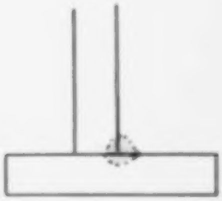
_____a. Temporary weld made to hold parts in alignment until final welds are made

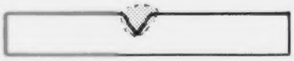
_____a. Weld made in groove formed by two beveled pieces of metal

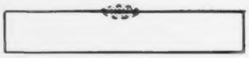
_____a. Weld made in corner or angle formed by two pieces of metal with welded surfaces at approximately 90-degree angles to each other

1. Tack weld
2. Bead weld
3. Fillet weld
4. Groove weld

19. Label types of welds illustrated below.

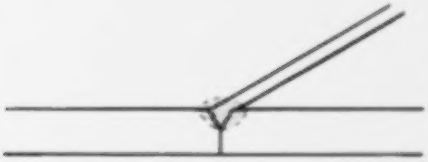


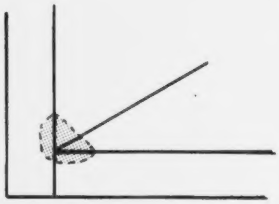




a. ____________________ b. ____________________ c. ____________________

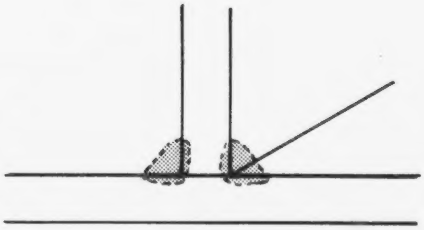
20. Label types of weld joints illustrated below and on the following page.



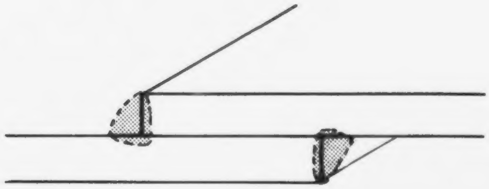


a. ______________________________ b. ______________________________

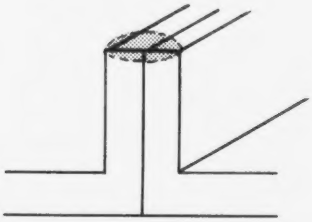
TEST



c. ______________________________



d. ______________________________

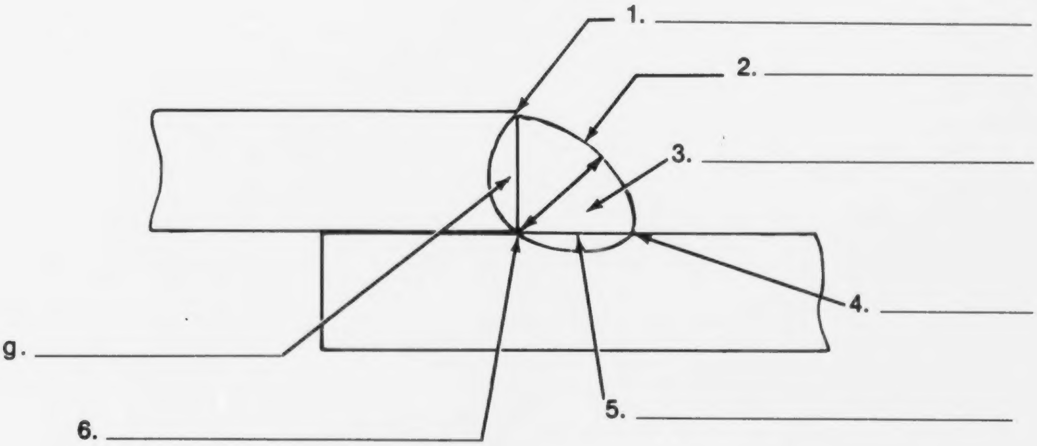


e. ______________________________

21. Identify parts of groove and fillet welds illustrated below and on the following page.

a. Fillet

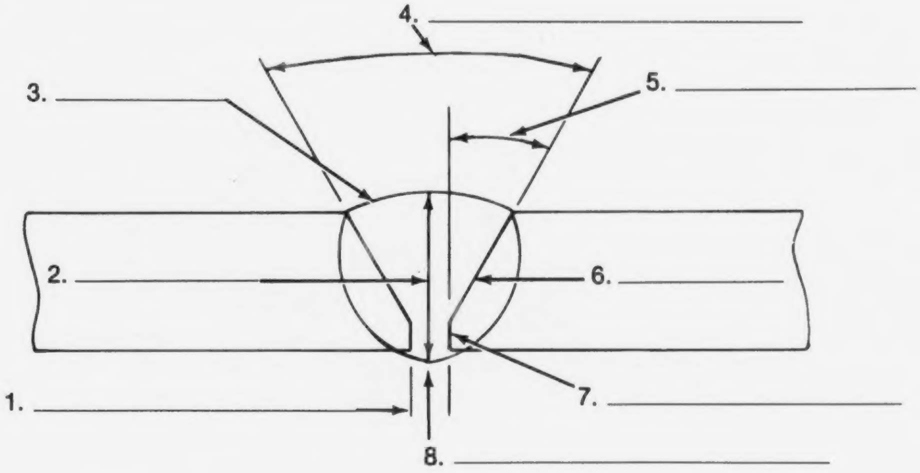
Face	**Toe**	**Root**
Throat	**Leg**	



TEST

b. Groove

Root
Face
Groove angle
Bevel angle
Root face
Groove face
Root opening
Throat



22. List positions used in arc welding.

a. ____________________

b. ____________________

c. ____________________

d. ____________________

23. List three reasons for poor welds.

a. ____________________

b. ____________________

c. ____________________

TEST

24. List four types of electrode motions (rod manipulations).

a. ____________________

b. ____________________

c. ____________________

d. ____________________

25. State three characteristics of a good weld.

a. ____________________

b. ____________________

c. ____________________

26. Match elements of welding symbols to their correct descriptions. Write the correct numbers in the blanks.

______a. Includes specification, process, or other reference

______b. Indicate type of weld

______c. Contains information for weld on side opposite arrow

______d. Indicate method of finish

______e. Indicate contour, backing or spacer material, melt-through, field weld, weld all around

______f. Contains information for weld on arrow side

______g. Points toward joint

______h. Details information pertinent to weld; shown inside tail

______i. Indicate size, length of weld; shown on same side of reference line as weld symbol

1. Reference line top
2. Reference line bottom
3. Arrow
4. Basic weld symbols
5. Dimensions and other data
6. Supplementary symbols
7. Finish symbols
8. Tail
9. Specification, process, or other reference

TEST

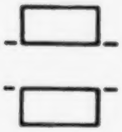
27. Draw symbols showing location of weld. Any weld symbol may be used.
    a. Weld on arrow side of joint

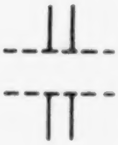
    b. Weld on other side of joint

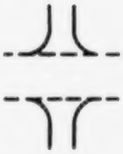
    c. Weld on both sides of joint

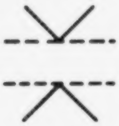
28. Identify basic weld symbols. Write the correct names in the blanks.

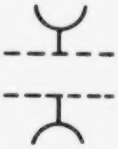
Edge flange
Corner flange
Surfacing
J-groove
Flared V-groove
Flared bevel groove
U-groove
Bevel groove
Square groove
Scarf groove
V-groove
Fillet
Plug or slot
Spot or projection
Seam
Back or backing

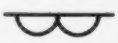

a. ____________________


b. ____________________

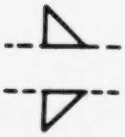

c. ____________________

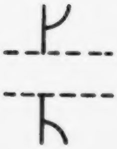

d. ____________________

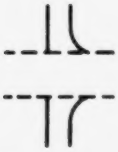

e. ____________________


f. ____________________

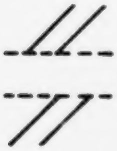
TEST

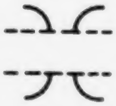


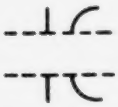




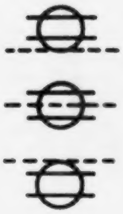
g. ____________________ h. ____________________ i. ____________________

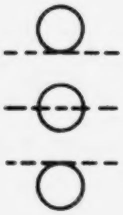


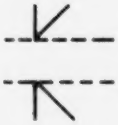




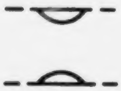
j. ____________________ k. ____________________ l. ____________________







m. ____________________ n. ____________________ o. ____________________

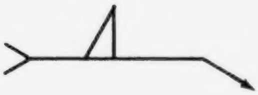


p. ______________________________

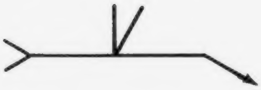
TEST

29. Distinguish between correct and incorrect drawings of symbols with one vertical side. Write a "C" in the blank before each correct drawing.

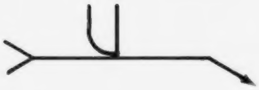
_____a.



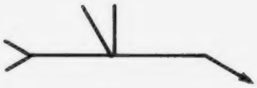
_____b.



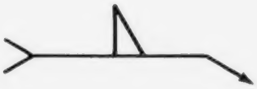
_____c.



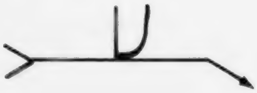
_____d.



_____e.



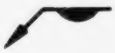
_____f.



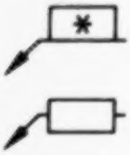
TEST

30. Identify supplementary symbols.

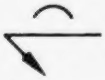
Backing or spacer material
Flush contour
Convex contour
Field weld
Melt-through
Weld all around
Concave contour



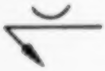
a. ________________________________



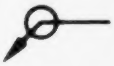
b. ________________________________



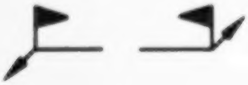
c. ________________________________



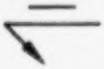
d. ________________________________



e. ________________________________

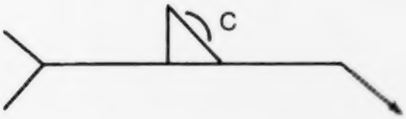


f. ________________________________

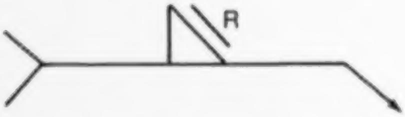


g. ________________________________

31. Interpret finish symbols used with contour symbols. Write the correct finish methods in the blanks.



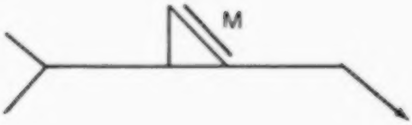
a. ________________________________

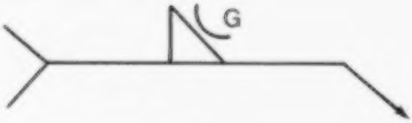


b. ________________________________

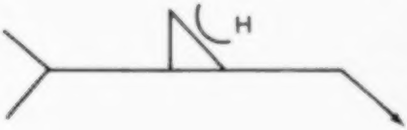
1363

TEST





c. ____________________ d. ____________________



e. ____________________

(NOTE: Test question 32 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

32. Demonstrate the ability to

    a. Start, stop, and restart a bead.

    b. Construct a pad weld.

    c. Construct a butt weld.

    d. Construct a lap-joint fillet weld in the overhead position.

    e. Construct a T-joint fillet weld in the vertical down position.

ARC WELDING
UNIT II

ANSWERS TO TEST

1. a. 6
   b. 9
   c. 1
   d. 4
   e. 7
   f. 10
   g. 2
   h. 8
   i. 3
   j. 5
   k. 12
   l. 11
   m. 13
   n. 17
   o. 14
   p. 15
   q. 16
   r. 21
   s. 20
   t. 18
   u. 19
   v. 22

2. a. AC — Alternating current; electric current that reverses its direction at regular intervals
   b. AWS — American Welding Society
   c. DC — Direct current; electric current flowing in one direction only and mostly constant in value
   d. OSHA — Occupational Safety and Health Act
   e. psi — Pounds per square inch

3. Answer should include any ten of the following

   a. Do not look at arc or reflection without eye protection
   b. Do not wear shield or helmet that is in bad condition
   c. Do not chip slag without wearing safety goggles
   d. Wear proper protective clothing
   e. Do not strike an arc until you have taken all safety precautions
   f. Do not weld around combustible or flammable materials
   g. Do not pick up hot metals with bare hands
   h. Be sure that confined areas are properly ventilated
   i. Disconnect plug before checking welding machine
   j. Do not leave electrode holder on welding table or in direct contact with grounded metal
   k. Do not use worn or frayed cables
   l. Be sure that floor is dry; do not stand in water when welding
   m. Keep work area clean
   n. Keep tools and materials in proper locations
   o. Dispose of electrode stubs properly

4. a. Alternating-current (AC) transformer welder
   b. Direct-current (DC) welder
   c. Motor generator
   d. Engine generator
   e. AC/DC transformer rectifier

5. a, b, c, e, f, h, i, k

ANSWERS TO TEST

6. a. 6
   b. 3
   c. 5
   d. 7
   e. 4
   f. 2
   g. 1

7. Answer should include any three of the following

   a. Mild steel
   b. Low-alloy steel
   c. Nickel steel
   d. Chromium/molybdenum steel
   e. Manganese/molybdenum steel
   f. Nickel/manganese/molybdenum steel
   g. Nickel/molybdenum/vanadium steel
   h. Aluminum
   i. Copper aluminum (aluminum bronze)
   j. Lead-bronze
   k. Phosphor bronze

8. a, b, e, f

9. a. E — Electric arc welding
   b. First two digits — Minimum tensile strength deposited in thousands of pounds per square inch
   c. Third digit — Welding position
      1) One — Indicates all positions
      2) Two — Indicates flat and horizontal only
      3) Three — Indicates flat only
   d. Fourth or last digit — Special characteristics and uses of the electrode

10. b

11. a, c

12. a, c, d, f, h

13. Answer should include any five of the following

    a. Plans and specifications
    b. Physical and chemical properties of base metal
    c. Composition of base metal
    d. Thickness and shape of base metal
    e. Welding position
    f. Welding current
    g. Joint design and fit-up
    h. Production efficiency and job conditions

ANSWERS TO TEST

14. Description should include the following
    - a. Raising amperes — Produces more heat; increases penetration
    - b. Lowering amperes — Produces less heat; decreases penetration

15. a. Scratching
    - b. Tapping

16. b, c

17. a. Slag
    - b. Weld
    - c. Gaseous shield
    - d. Angle of electrode 15 to 30 degrees
    - e. Electrode
    - f. Wire core
    - g. Coating (flux)
    - h. Arc
    - i. Crater
    - j. Penetration
    - k. Direction of travel
    - l. Base metal
    - m. Heat lines

18. a. 2
    - b. 1
    - c. 4
    - d. 3

19. a. Fillet
    - b. Groove
    - c. Bead

20. a. Butt
    - b. Corner
    - c. T
    - d. Lap
    - e. Edge

21. A. Fillet
    1. Toe
    2. Face
    3. Throat
    4. Toe
    5. Leg
    6. Root
    7. Leg

    B. Groove
    1. Root opening
    2. Throat
    3. Face
    4. Groove angle
    5. Bevel angle
    6. Groove face
    7. Root face
    8. Root

ANSWERS TO TEST

22. a. Flat
    b. Horizontal
    c. Vertical
    d. Overhead

23. Answer should include any three of the following

    a. Incorrect machine adjustment
    b. Too large or too small electrode
    c. Improper movement of electrode
    d. Improper angle of electrode
    e. Improper preparation of base metal
    f. Incorrect arc length

24. Answer should include any four of the following

    a. Small oscillating motion
    b. Small circular motion
    c. Back-and-forth motion with half circle
    d. Figure-eight motion
    e. Triangular motion

25. Answer should include any three of the following

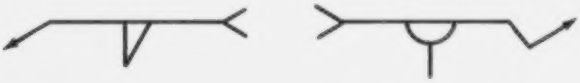
    a. Smooth edges
    b. Correct bead size
    c. Even penetration (well-fused)
    d. Even ripple
    e. Clean, bright weld
    f. Slight crown

26. a. 8
    b. 4
    c. 1
    d. 7
    e. 6
    f. 2
    g. 3
    h. 9
    i. 5

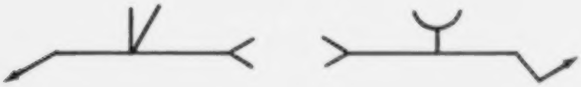
ANSWERS TO TEST

27. Student may use any weld symbol in the following positions.

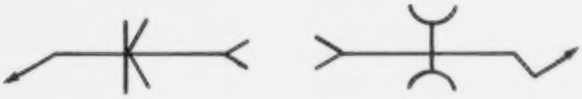
a.



b.



c.



28.
- a. Plug or slot
- b. Square groove
- c. Edge flange
- d. V-groove
- e. U-groove
- f. Surfacing
- g. Fillet
- h. J-groove
- i. Corner flange
- j. Scarf groove
- k. Flared V-groove
- l. Flared bevel groove
- m. Seam
- n. Spot or projection
- o. Bevel groove
- p. Back or backing

29. b, e, f

30.
- a. Melt-through
- b. Backing or spacer material
- c. Convex contour
- d. Concave contour
- e. Weld all around
- f. Field weld
- g. Flush contour

31.
- a. Chipped
- b. Rolled
- c. Machined
- d. Ground
- e. Hammered

32. Performance skills evaluated to the satisfaction of the instructor

OXYACETYLENE CUTTING
UNIT III

UNIT OBJECTIVE

After completing this unit, the student should be able to set, light, adjust, and use an oxyacetylene cutting outfit. The student will show this knowledge by completing job sheets and unit test with a minimum score of 85 percent.

SPECIFIC OBJECTIVES

After completing this unit, the student should be able to

1. Match terms associated with oxyacetylene cutting to their correct definitions.
2. State color codes for oxygen and acetylene.
3. Arrange in order stages in the oxyacetylene cutting process.
4. Identify the parts of an oxyacetylene cutting outfit.
5. Identify the parts of a torch body and cutting attachment.
6. State safety rules for working with oxyacetylene equipment.
7. Identify types of oxyacetylene cutting flames.
8. Distinguish between flashback and backfire.
9. Arrange in order steps to follow in case of flashback.
10. Select from a list causes of backfire.
11. Match common cutting-torch tips to their correct uses.
12. Identify a multiflame heating nozzle (rosebud) and tip.
13. Describe uses of a multiflame heating nozzle (rosebud).
14. Identify temperature sticks (temp-sticks).
15. Describe the selection and use of temperature sticks (temp-sticks)
16. Demonstrate the ability to
    a. Set up equipment for oxyacetylene cutting.
    b. Turn on, light, adjust to a neutral flame, and turn off oxyacetylene cutting equipment.

OBJECTIVE SHEET

c. Cut mild steel at a 90-degree angle, stop, and restart the cut.

d. Cut round stock.

e. Cut cable.

OXYACETYLENE CUTTING
UNIT III

SUGGESTED ACTIVITIES

I. Unit contents

  A. Objective sheet

  B. Suggested activities

  C. Transparency masters

    1. TM #1 — Oxygen Regulator Gauges

    2. TM #2 — Acetylene Regulator Gauges

  D. Information sheet

  E. Job sheets

    1. Job Sheet #1 — Set Up Equipment for Oxyaetylene Cutting

    2. Job Sheet #2 — Turn On, Light, Adjust to a Neutral Flame, and Turn Off Oxyacetylene Cutting Equipment

    3. Job Sheet #3 — Cut Mild Steel at a 90-Degree Angle, Stop, and Restart the Cut

    4. Job Sheet #4 — Cut Round Stock

    5. Job Sheet #5 — Cut cable

  F. Test

  G. Answers to test

II. Instructor's guide

  A. Review unit and plan presentation.

  B. Obtain materials to supplement unit.

    1. Order films.

      a. *Flame Cutting*. Color, 20 minutes, MacMillian Films, 1972. Available from MacMillian Films, 34 MacQuesten Parkway South, Mount Vernon, New York 10550, 914/664-5051.

      (NOTE: This film provides step-by-step instructions for making straight-line cuts, cutting irregular shapes, beveling plate edges, and making circle cuts. It gives excellent instructions on freehand cutting with oxyacetylene cutting torch.)

SUGGESTED ACTIVITIES

b. *The Cutting Torch — Flame Cutting*. Color, 18 minutes, BFA Educational Media, 1972. Available from BFA Educational Media, 468 Park Avenue South, New York, New York 10016, 212/684-5910.

(NOTE: This film covers the many aspects of tip selection and the procedures for using the torch.)

(NOTE: These films are available on a free-loan basis to Oklahoma teachers from the Oklahoma State Department of Vocational and Technical Education, Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074. Out-of-state teachers must order from the addresses listed above.)

c. *Don't Push Your Luck*. Color, 12 minutes, Harvest Films, 1978. Available from Harvest Films, Inc., 309 5th Avenue, New York, New York 10016, 212/648-7950.

(NOTE: Bill Frank, the actual victim, recreates his real-life blinding accident. He delivers to employees a powerful safety message on face and eye protection.)

2. Order slide/cassette programs and filmstrips

a. *There's Something in the Air*. Thirty slides with cassette, National Safety Council, n.d. Available from National Safety Council, P.O. Box 11933, Chicago, Illinois 60611, 312/527-4800.

(NOTE: This program tells workers how to protect themselves from contaminated air — fogs, mists, fumes, gases, smokes, sprays, and vapors — that could be harmful to their lungs.)

b. *Oxyacetylene Cutting Explained*. Two color filmstrips, 2 cassettes, 12 to 13 minutes each, Bergwall Productions, Inc., n.d. May be purchased from Bergwall Productions, 839 Steward Avenue, P.O. Box 238, Garden City, New York 11530. Call toll-free 800/645-3565.

(NOTE: Part 1, *Setting Up Equipment*, explains cutting operation: cutting tip, attaching tip to torch body, lighting and testing flame, purging the line and shutting down the unit. Part 2, *Specialized Oxyacetylene Cutting*, demonstrates torch angle, correct cutting procedure, lighting and testing the flame, cutting thin and heavy stock, chamfering, constructing and using guide for cutting a circle, and piercing stock.)

3. Order transparencies and competency profiles.

(NOTE: Transparencies and competency profiles for this book are available from the Oklahoma State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, 1500 West Seventh Avenue, Stillwater, Oklahoma 74074, or from The Associated General Contractors of America, 1957 E Street, N.W., Washington, DC 20006, phone 202/393-2040.)

SUGGESTED ACTIVITIES

4. Gather equipment and materials for job sheet demonstrations.

5. Get color flame charts from welding supplier to show types of flames.

6. Contact local welding supplier for materials on cutting techniques, pressurized gas, safety equipment, and other items of interest.

C. Introduce unit by pointing out to students the versatility of the cutting torch for all types of metal construction and repair.

SUGGESTIONS:

- Give examples of the uses of the cutting torch in commercial construction
- Explain that people skilled with a cutting torch and in arc/welding obtain well-paying jobs.

D. Provide students with objective sheet.

E. Discuss unit and specific objectives.

SUGGESTIONS:

- Emphasize to students that the major thrust of the unit is to learn how to use the cutting torch safely and skillfully.
- Point out briefly what the main emphasis of each objective is and how all of the objectives build on each other to provide the knowledge and skills needed to accomplish the unit objective.

F. Provide students with information and job sheets.

G. Discuss information and job sheets.

1. Discuss terms and definitions associated with oxyacetylene cutting. Use Information Sheet, Section I, and an actual oxyacetylene cutting rig.

   SUGGESTION:

   - Bring the oxyacetylene cutting rig into the classroom to illustrate some of the terms.

2. Discuss the color codes for oxygen and acetylene; use Information Sheet, Section II. Also discuss characteristics of the gases.

   SUGGESTIONS:

   - Release some oxygen into the classroom air to show students that oxygen is colorless and odorless.
   - Perform the following demonstration to emphasize that oxygen supports and intensifies combustion.

SUGGESTED ACTIVITIES

a. Position a small burning candle on a table.

b. Set a glass container over the candle; the candle will burn out when the oxygen trapped in the container is used up.

c. Relight the candle.

d. Fill the container with oxygen from the torch, maintaining as good a seal as possible with your hand.

e. Quickly set the oxygen-filled container down over the lighted candle to illustrate how the high concentration of oxygen intensifies the flame.

3. Discuss the cutting process. Use Information Sheet, Section III.

SUGGESTIONS:

- Emphasize to students that the preceding demonstration showed how oxygen can intensify flame temperature.
- Remind students that flame temperatures range from 5600°F to 6300°F.
- Perform a cutting demonstration to show how the molten metal is blown out by the pressure of the oxygen.

5. Discuss the parts of the oxyacetylene cutting equipment. Use Information Sheet, Section IV; Transparencies #1 and #2; and the actual equipment.

SUGGESTIONS:

- Use unassembled equipment when starting this discussion, thereby demonstrating the process in Job Sheet #1 as the equipment is put together and each part is explained.
- Stress to the students the importance of knowing all of the parts of the cutting rig and their proper names.
- Show students the proper way to hold a flint lighter and to strike a spark.
- Stress the importance of always checking the lens of the cutting goggles or shaded face shield.

EXAMPLE: Recommended shade numbers for oxygen cutting

3 or 4 — Metal up to 1 inch thick
4 or 5 — Metal 1 inch to 6 inches thick
5 or 6 — Metal 6 inches thick and over

SUGGESTED ACTIVITIES

5. Use Information Sheet, Section V and actual torches to discuss parts of a torch body and cutting attachment; explain the purpose of each part.

6. Discuss safety precautions for oxyacetylene cutting. Use Information Sheet, Section VI, as well as the actual cutting rig.

   SUGGESTIONS:

   - Review Job Sheet #1, emphasizing safety precautions as you work through the procedures.
   - Emphasize that the oxyacetylene cutting rig is potentially one of the most dangerous pieces of equipment in the shop, but it is safe if it is cared for and used properly.

7. Discuss and demonstrate the types of oxyacetylene flames. Use Section VII of the Information Sheet and actual torch flames.

   SUGGESTIONS:

   - Show films on flame cutting.
   - Explain how to recognize the different oxyactylene flames and how to adjust the torch to the desired flame.
   - After demonstrating how to adjust the lighted torch to the various types of flames, allow each student to adjust the lighted torch.

8. Use Information Sheet, Section VIII to discuss flashback and backfire.

9. Use Information Sheet, Section IX to discuss steps to follow in case of flashback.

   SUGGESTIONS:

   - Require students to know these steps in correct order before they are allowed to operate a torch.
   - Explain the logic of the steps as they are performed.
   - Remind the students that check valves become a valuable investment in the event of a flashback.

10. Discuss causes of backfire. Use Information Sheet, Section X.

    SUGGGESTIONS:

    - Stress that should a torch backfire, the problem must be analyzed and corrected before continued use.
    - Stress to students that even if they as operators are at fault, backfire must be reported to the instructor immediately so that corrections can be made.

SUGGESTED ACTIVITIES

11. Use Information Sheet, Section XI to discuss cutting torch tips and their uses.

    SUGGESTIONS:

    - Show sample tips and how to install and use them.
    - Emphasize uses in the carpentry trade, such as where specific metals, tips, and rods might be used.

12. Use Information Sheet, Sections XII and XIII to discuss multiflame heating nozzles and their uses.

13. Use Information Sheet, Section XIV and XV to discuss temp-sticks and their use.

14. Provide students with remaining job sheets and domonstrate the procedures.

15. Allow students to practice procedures.

H. Review unit.

I. Give test.

J. Critique test and discuss in class.

K. Reteach and retest as required.

L. Complete appropriate sections of competency profiles.

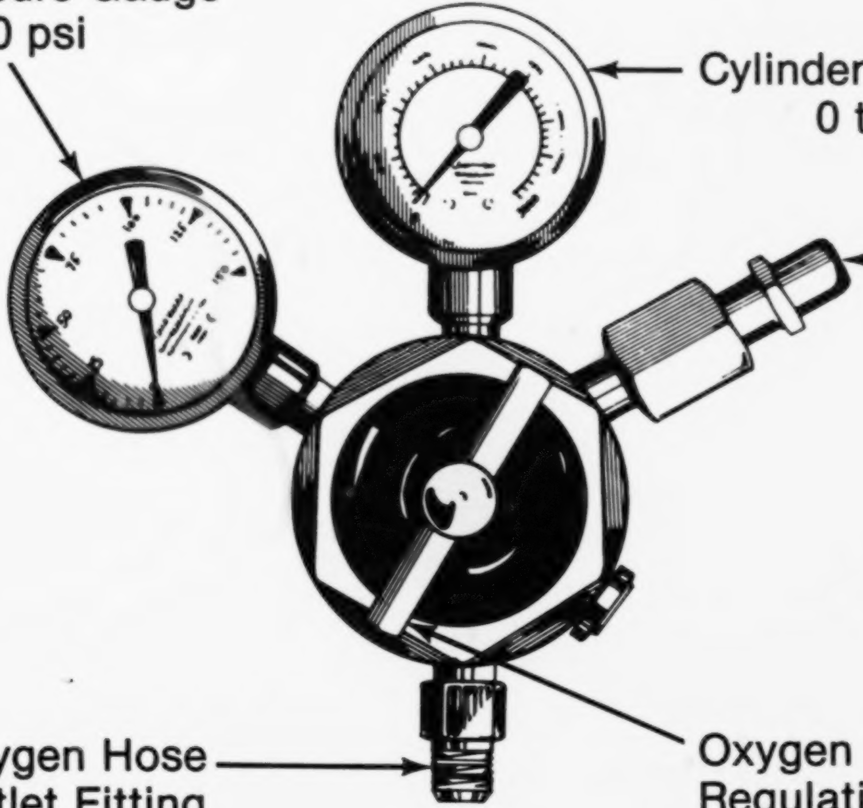
III. Unit references

A. Althouse, Andrew P., and Carl H. Turnquist, and William A. Bowditch. *Modern Welding*. Homewood, Illinois; Goodheart-Willcox Company, 1965.

B. Hendrix, Laborn J., "Bud" *Heavy Equipment Machanic*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1984.

C. Hendrix, Laborn J., "Bud" *Millwright Instructional Materials*. Stillwater, Oklahoma: State Department of Vocational and Technical Education/Curriculum and Instructional Materials Center, and The Associated General Contractors of America, 1980.

Oxygen Regulator Gauges



Working Pressure Gauge
0 to 150 psi

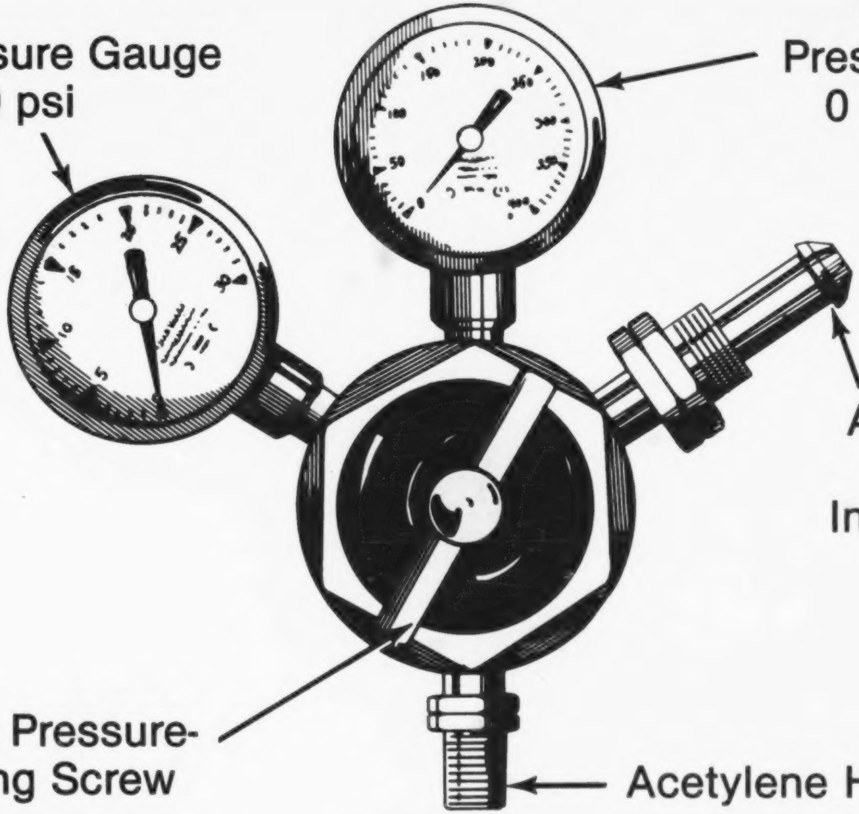
Cylinder Pressure Gauge
0 to 3,000 psi

Oxygen Cylinder
Inlet Fitting

Oxygen Hose
Outlet Fitting

Oxygen Pressure-
Regulating Screw

Acetylene Regulator Gauges


Working Pressure Gauge 0 to 30 psi
Cylinder Pressure Gauge 0 to 400 psi
Acetylene Cylinder Inlet Fitting
Acetylene Pressure-Regulating Screw
Acetylene Hose Outlet Fitting

OXYACETYLENE CUTTING
UNIT III

INFORMATION SHEET

I. Terms and definitions

   A. Acetylene — Colorless, gaseous hydrocarbon used in cutting and welding

      (NOTE: Other gases are also used in cutting.)

   B. Oxygen — Element that is normally a colorless, odorless, and tasteless gas; used in combination with other substances in cutting and welding

   C. Oxyacetylene cutting — Flame cutting of metal in which the preheating of the metal is accomplished with a flame produced by an oxyacetylene torch

   D. Purge — To remove any foreign material from a system or component by flushing with the gas used in that system

   E. psi — Pounds per square inch

   F. Combustible — Capable of burning

   G. Toxic — Poisonous

   H. Flint lighter — Striker used to ignite torch

   I. Slag box — Metal container with a layer of water or sand to catch hot material

   J. Slag — Metal that melts away during the oxyacetylene cutting process

   K. Seizing — Firmly binding cable with soft iron wire

II. Color codes for oxygen and acetylene

   A. Oxygen — Green

   B. Acetylene — Red

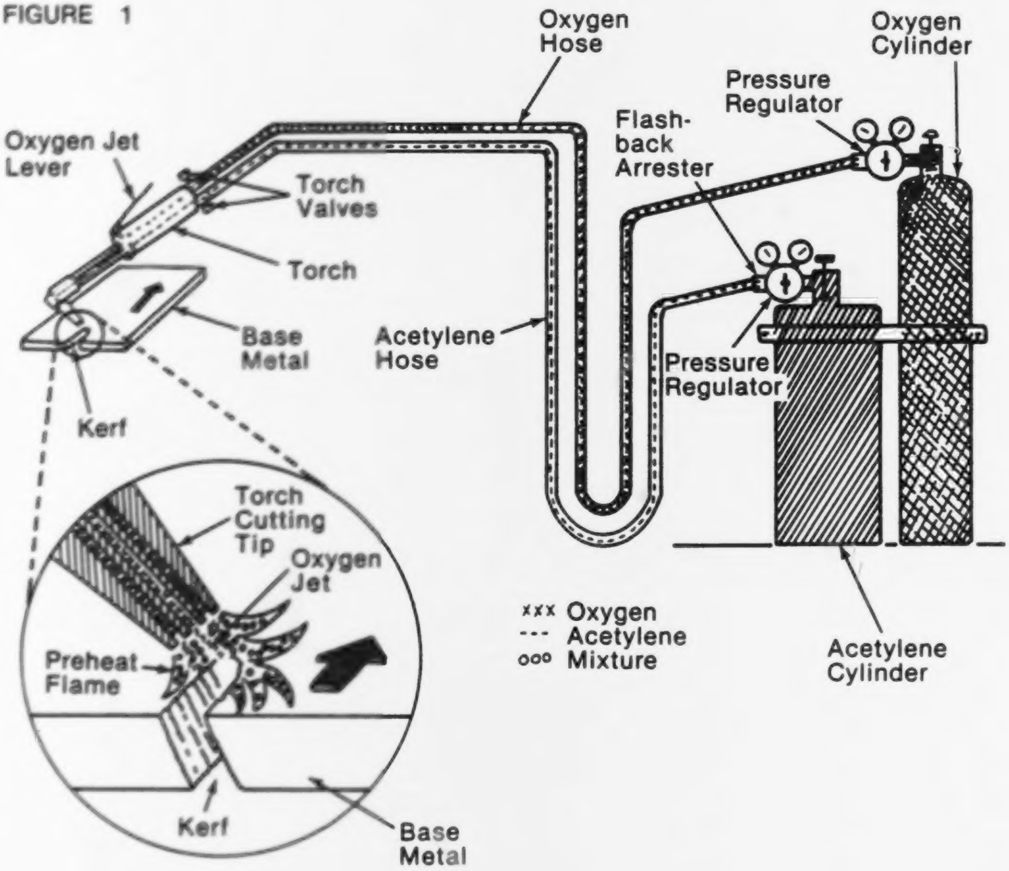
III. Stages in the oxyacetylene cutting process (Figure 1)

   (NOTE: A flame of oxygen mixed with acetylene [or other gas] heats the base metal; then an oxygen jet cuts the heated metal. Oxyacetylene cutting is one of the most popular methods of cutting and shaping steel.)

INFORMATION SHEET

EXAMPLE:

FIGURE 1


Oxygen Hose
Oxygen Cylinder
Pressure Regulator
Flash-back Arrester
Oxygen Jet Lever
Torch Valves
Torch
Base Metal
Acetylene Hose
Pressure Regulator
Kerf
Torch Cutting Tip
Oxygen Jet
Preheat Flame
Kerf
Base Metal
xxx Oxygen
--- Acetylene
ooo Mixture
Acetylene Cylinder

A. Pressure-regulated acetylene and pressure-regulated compressed oxygen are supplied from two cylinders

(NOTE: Each cylinder has two pressure gauges. The cylinder pressure gauge indicates pressure in the cylinder [high], and the working pressure gauge indicates the pressure of the gas being fed to the torch [low].)

B. Separate, flexible hoses carry gases to torch

(NOTE: Two needle valves control the flow of gas.)

C. Operator ignites acetylene gas with spark from flint lighter

INFORMATION SHEET

D. Operator opens oxygen torch valve, and gases are mixed inside torch

E. Mixture burns at several orifices (preheat orifices) in torch tip

F. Flame heats base metal to a dull, cherry red

G. Operator presses oxygen lever, and jet of oxygen rushes out of cutting orifice

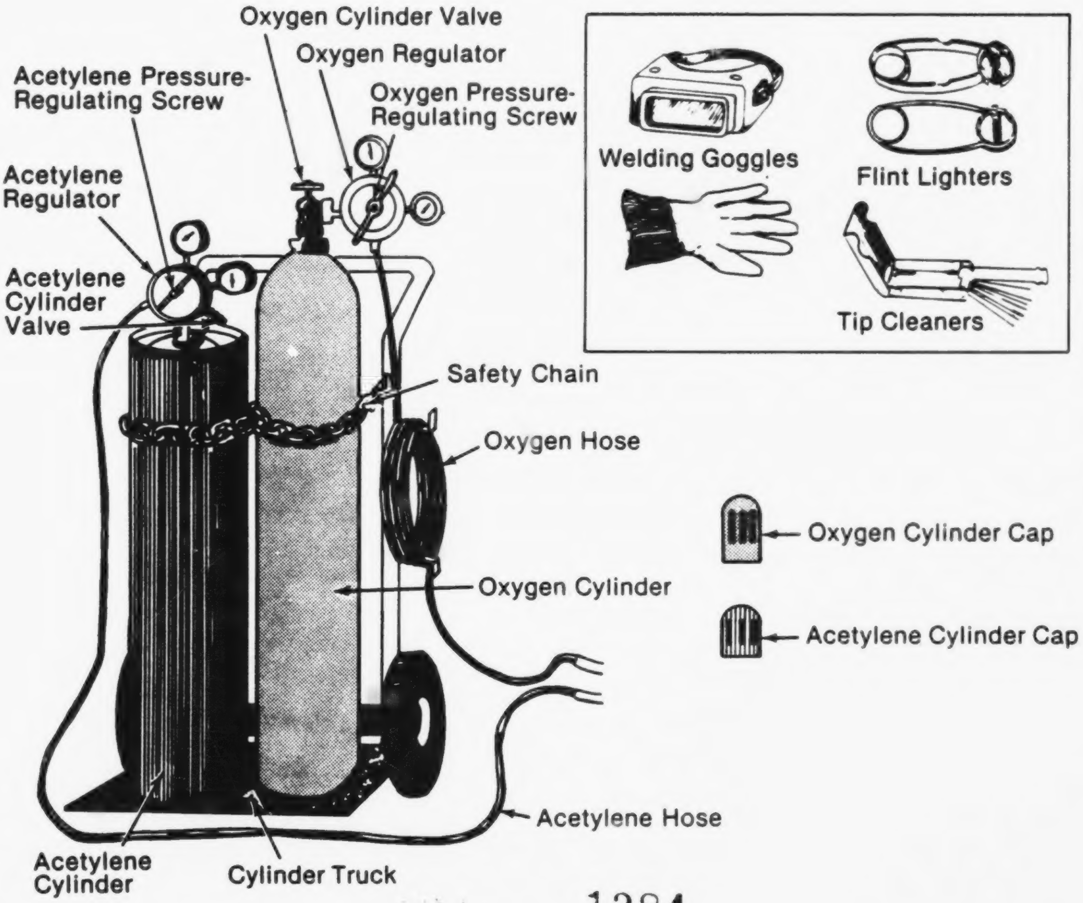
H. Oxygen jet quickly oxidizes the heated base metal and blows it away

I. Removal of material leaves a cut in the metal

IV. Parts of an oxyacetylene cutting outfit (Figure 2)

(NOTE: As an added safety feature, some outfits are equipped with antiflashback valves between regulator and torch.)

FIGURE 2

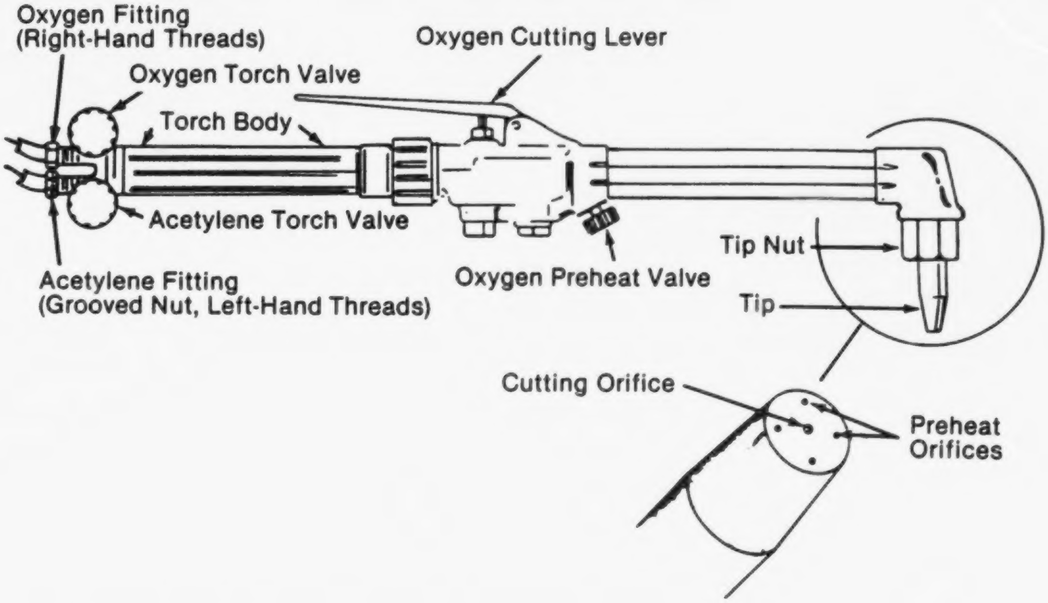

Oxygen Cylinder Valve
Oxygen Regulator
Acetylene Pressure-Regulating Screw
Oxygen Pressure-Regulating Screw
Acetylene Regulator
Acetylene Cylinder Valve
Welding Goggles
Flint Lighters
Tip Cleaners
Safety Chain
Oxygen Hose
Oxygen Cylinder Cap
Oxygen Cylinder
Acetylene Cylinder Cap
Acetylene Hose
Acetylene Cylinder
Cylinder Truck

INFORMATION SHEET

V. Parts of a torch body and cutting attachment (Figure 3)

(NOTE: The preheat orifices heat metal to a kindling point of approximately 1,600°F [755°C]. The cutting orifice removes oxidized metal.)

FIGURE 3


Oxygen Fitting (Right-Hand Threads)
Oxygen Cutting Lever
Oxygen Torch Valve
Torch Body
Acetylene Torch Valve
Acetylene Fitting (Grooved Nut, Left-Hand Threads)
Oxygen Preheat Valve
Tip Nut
Tip
Cutting Orifice
Preheat Orifices

VI. Safety rules for working with oxyacetylene equipment

(NOTE: Instructor may add other safety rules. The chief dangers of oxyacetylene cutting are burns and toxic fumes. Pay attention at all times, and notice how you feel.)

CAUTION

If you feel dizzy or nauseated or if you have blurred vision, stop cutting and get some fresh air.

A. Make sure that either foam or a multipurpose dry-chemical fire extinguisher is readily available and in working condition

B. Wear welding goggles, gloves, and protective clothing

CAUTION

Keep gloves, hands, and clothing free of oil and grease.

INFORMATION SHEET

C. Wear gloves to handle hot metal

D. Use open torch only in a well-ventilated place

E. Avoid breathing toxic fumes

EXAMPLES: Galvanized metal fumes, some paint fumes

F. Do not leave a burning torch unattended

G. Secure cylinders in a safe place

(NOTE: Secure cylinders to protect valves and regulators and to prevent injuries.)

H. Cut or weld at least 5 feet from cylinders

I. Always use regulators; do not use oxygen or acetylene directly from cylinders

(NOTE: Be sure that regulators are used only on the cylinders that they were designed to be used on.)

J. Use flint lighters, not matches, for lighting torch

K. Use hoses designated for oxygen and acetylene only

L. Do not use oil on regulators, torches, fittings, or any equipment surface that may come in contact with oxygen

CAUTION

Never oil or grease oxygen fittings. Substances will ignite with a violent explosion.

M. Do not use compressed oxygen to clean off clothing

CAUTION

Do not confuse compressed oxygen with compressed air. Oxygen speeds up combustion, and oxygen-soaked clothing needs only a spark to burst into flame.

N. Do not breathe compressed oxygen directly from cylinder or hose

O. Use soapsuds and paintbrush to test connections for leaks

P. Do not use acetylene at pressures higher than 15 pounds per square inch

CAUTION

Acetylene becomes unstable and highly explosive when pressure is over 15 psi.

Q. Do not cut or weld directly on gravel or concrete

R. Keep heat, flames, and sparks away from combustibles

S. Do not cut or weld on containers that have been used to store combustible materials unless containers have been properly cleaned and purged

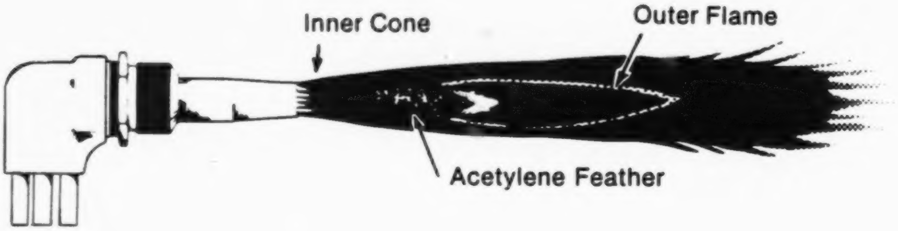
EXAMPLES: Containers that have held gases such as nitrogen, carbon dioxide, or argon

VII. Types of oxyacetylene cutting flames (Figures 4-6)

A. Carburizing flame

(NOTE: The flame illustrated has an excess of acetylene gas.)

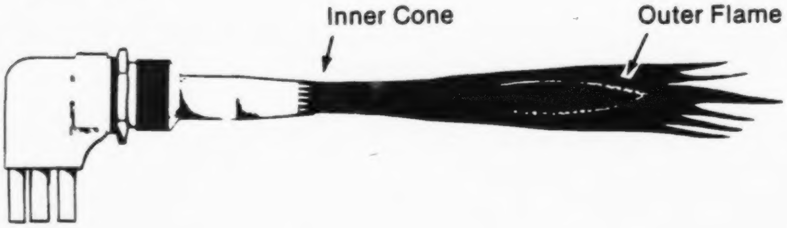
FIGURE 4



B. Neutral flame

(NOTE: The flame illustrated has the proper ratio of oxygen to acetylene.)

FIGURE 5

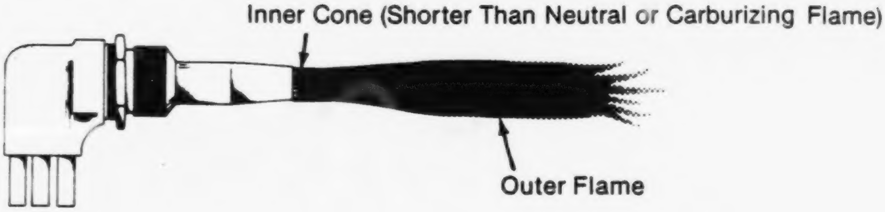


INFORMATION SHEET

C. Oxidizing flame

(NOTE: The flame illustrated has an excess of oxygen.)

FIGURE 6



VIII. Differences between flashback and backfire

A. Flashback — Flame disappears inside torch body; at the same time, a squealing noise occurs and smoke and/or sparks are emitted from the torch tip

B. Backfire — Flame burns momentarily back into tip; then a loud snap or pop is emitted from the torch and the flame either goes out or continues to burn in a normal manner

IX. Steps to follow in case of flashback

A. Close oxygen preheat valve

B. Close oxygen torch valve

C. Close acetylene torch valve

D. Release oxygen pressure-regulating screw

E. Release acetylene pressure-regulating screw

F. Examine acetylene unit

G. Reset regulator pressures

H. Light torch

(NOTE: If heavy smoke comes out of the torch tip and the torch body becomes hot, the flashback has probably traveled past the mixing chamber into the hose. In this case, shut off the oxygen and acetylene cylinder, and then notify the supervisor.)

INFORMATION SHEET

X. Causes of backfire

(NOTE: The causes listed below should be carefully checked to control backfire.)

A. Not enough acetylene or oxygen pressure for the tip size used

B. Loose cutting tip

C. Dirty tip

(NOTE: Tip may have deposits or metal particles inside orifice. These deposits may overheat and act at ignitors.)

D. Overheating of cutting tip

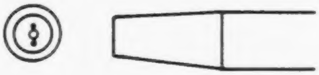
E. Bad O-ring in torch body

XI. Common cutting-torch tips and their uses (Figures 7-17)

(NOTE: Most of the following cutting tips are available in two or more sizes and should be selected on the basis of the thickness of the metal to be cut and the job to be performed.)

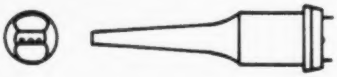
A. Straight-line or circular cutting of clean plate

FIGURE 7



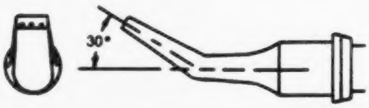
B. Splitting angle iron, trimming plate, and cutting sheet metal

FIGURE 8



C. Hand cutting rivet heads; machine cutting 30-degree bevels

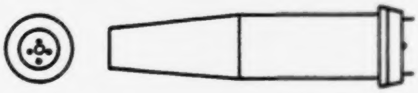
FIGURE 9



INFORMATION SHEET

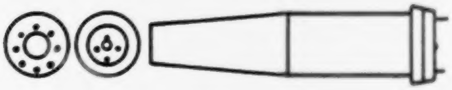
D. Straight-line or shape cutting of clean plate

FIGURE 10



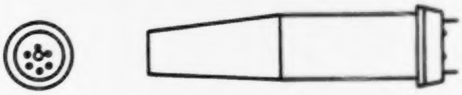
E. Cutting rusty or painted surfaces

FIGURE 11



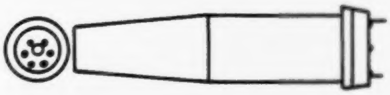
F. Cast-iron cutting and preparing welding Vs

FIGURE 12



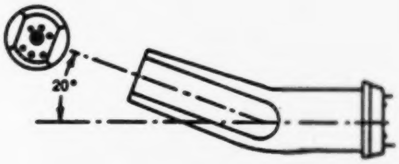
G. General cutting; cutting cast iron and stainless steel

FIGURE 13



H. Grooving, flame machining, gouging, and removing imperfect welds

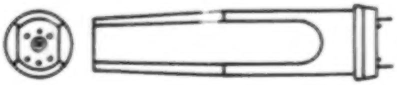
FIGURE 14



INFORMATION SHEET

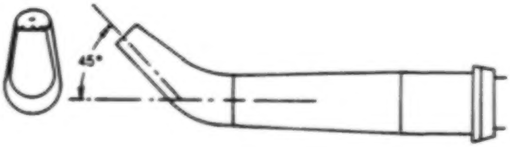
I. Grooving, gouging, or removing imperfect welds

FIGURE 15



J. Machine cutting 45-degree bevels or hand cutting rivet heads

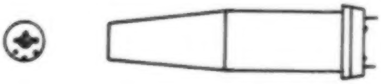
FIGURE 16



K. Removing rivet heads (washing)

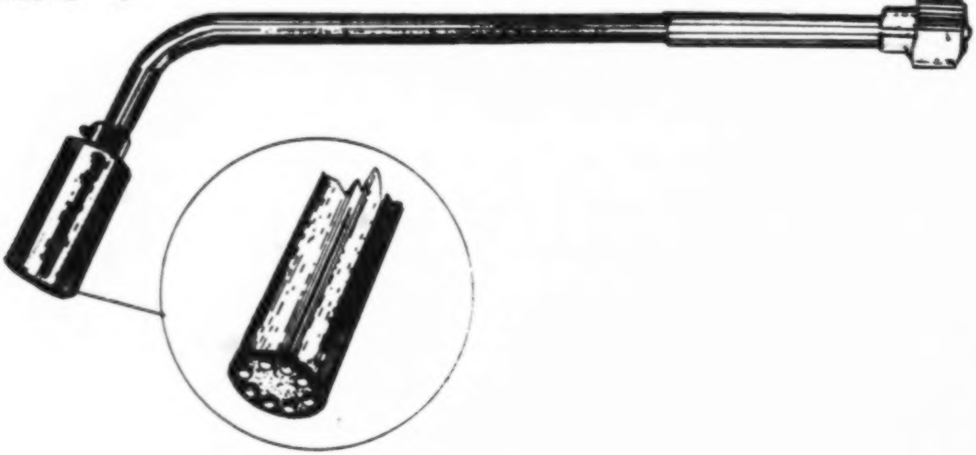
(NOTE: Flared cutting orifices provide oxygen stream of low velocity.)

FIGURE 17



XII. Multiflame heating nozzle (rosebud) and tip (Figure 18)

FIGURE 18



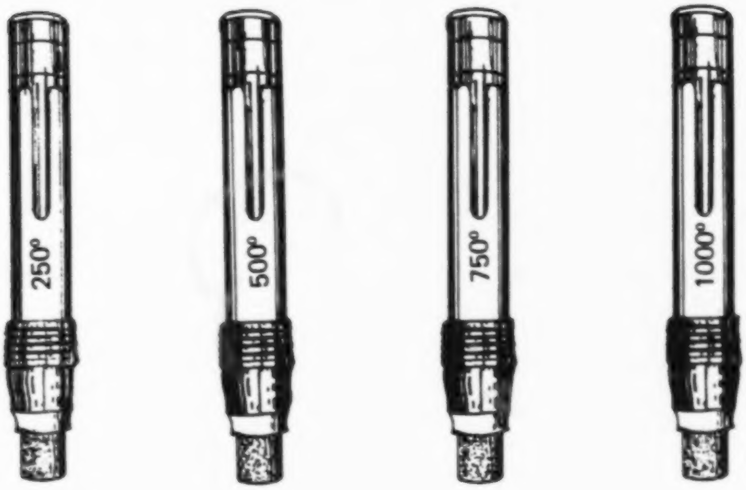
INFORMATION SHEET

XIII. Uses of a multiflame heating nozzle (rosebud) — Used to heat parts or metals before fitting them together; also used to preheat metal before welding

XIV. Temperature sticks (temp-sticks) (Figure 19)

(NOTE: Temp-sticks come in a variety of colors but this has nothing to do with the heat range.)

FIGURE 19



XV. Selection and use of temperature sticks (temp-sticks)

A. Selection

1. Temperature sticks come in a wide variety for different temperatures

2. The proper temperature stick is determined by the type of metal or part being used or by the specifications

EXAMPLES: Bearings — 800°

Preheat before welding — 500°

B. Use

1. Used during the heating process

2. Mark dissipates when the metal or part has reached the proper temperature

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #1 — SET UP EQUIPMENT FOR OXYACETYLENE CUTTING

I. Equipment and materials

A. Oxygen cylinder

B. Acetylene cylinder

C. Oxygen regulator

D. Acetylene regulator

E. Hoses

F. Wrench

G. Cylinder truck

H. Foam or multipurpose dry-chemical fire extinguisher

I. Soapsuds

(NOTE: Ivory Soap is recommended for making soapsuds.)

J. Clean paintbrush

K. Torch body with tips

L. Welding goggles

M. Coveralls or protective clothing free of oil and grease

II. Procedure

A. Fasten cylinders in a vertical position on cylinder truck

> **CAUTION**
>
> To prevent damage to valves, never use acetylene from a cylinder that is not in a vertical position. Valve damage might cause cylinder to explode.

B. Remove caps from cylinders

C. Crack valves of each cylinder to remove foreign material; close valves

D. Connect oxygen regulator to oxygen cylinder

> **CAUTION**
>
> Do not use oil or any thread compound on any connections in the oxyacetylene system.

    1. Turn oxygen pressure-regulating screw counterclockwise until tension on spring is released

    2. Slowly turn cylinder valve wide open

E. Connect acetylene regulator to acetylene cylinder

    1. Turn acetylene pressure-regulating screw counterclockwise until tension on spring is released

    2. Open cylinder valve one-half to three-quarters of a turn

    (NOTE: Never open cylinder valve more than one and one-half turns. Leave wrench with cylinder.)

F. Connect acetylene hose to acetylene regulator; purge hose

G. Connect oxygen hose to oxygen regulator; purge hose

H. Connect torch body to oxygen and acetylene hoses

I. Close both valves on torch body

J. Attach cutting attachment to torch body

(NOTE: The tip size is determined by the thickness of metal to be cut and the manufacturer's instructions.)

K. Close oxygen preheat valve on cutting attachment

L. Turn oxygen pressure-regulating screw clockwise until working pressure is reached

M. Turn acetylene pressure-regulating screw clockwise until correct working pressure is reached

CAUTION

At pressure higher than 15 psi, acetylene becomes unstable and highly explosive.

N. Use soapsuds to test all connections for leaks

(NOTE: Apply soapsuds with a clean paintbrush.)

O. Close regulator valves

P. Proceed to Job Sheet #2

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #2 — TURN ON, LIGHT, ADJUST TO A NEUTRAL FLAME, AND TURN OFF OXYCETYLENE CUTTING EQUIPMENT

I. Equipment and materials

- A. Oxyacetylene cutting outfit with tip assembly
- B. Wrench
- C. Welding gloves
- D. Welding goggles
- E. Coveralls or protective clothing free of oil and grease
- F. Flint lighter
- G. Foam or multipurpose dry-chemical fire extinguisher
- H. Tip cleaners

II. Procedure

A. Check all cylinder, regulator, and torch valves to make sure that they are closed

B. Open acetylene cylinder valve one-half to three-quarters of a turn

CAUTION

Never open cylinder valve more than one and one-half turns.

C. Open acetylene valve on torch one turn

D. Turn acetylene pressure-regulating screw clockwise until desired pressure is reached

(NOTE: Oxygen and acetylene pressures and size of tip depend upon the thickness of metal to be cut. Use pressures and tip size recommended by manufacturer.)

CAUTION

Acetylene becomes unstable and highly explosive at pressures higher than 15 psi.

E. Close acetylene valve on torch

F. Open oxygen cylinder valve all the way

JOB SHEET #2

G. Open oxygen torch valve all the way

H. Open oxygen preheat valve on cutting attachment one turn

I. Turn oxygen pressure-regulating screw clockwise until desired pressure is reached

J. Close oxygen preheat valve on cutting attachment

K. Open acetylene valve on torch one-quarter turn

L. Clean tip

(NOTE: Clean tip before lighting torch and as often as needed.)

M. Light torch with flint lighter and adjust until smoke on flame clears

N. Open oxygen preheat valve slowly and adjust to a neutral flame

O. Depress oxygen cutting lever, and check to see that a neutral flame is present

(NOTE: If necessary, adjust the oxygen preheat valve with the oxygen cutting lever depressed until a neutral flame is secured. Pressure rises slightly when valve is closed.)

P. Close acetylene valve on torch

Q. Close acetylene cylinder valve

R. Close oxygen preheat valve

S. Close oxygen cylinder valve

T. Open acetylene valve on torch

(NOTE: When gauges reach zero, close torch valve and release acetylene pressure-regulating screw by turning counterclockwise.)

U. Open oxygen preheat valve on torch

(NOTE: When gauges reach zero, close oxygen preheat valve and turn oxygen pressure-regulating screw counterclockwise.)

V. Close oxygen valve on torch

W. Place torch and hose on hanger or brackets provided

(NOTE: If regulators are removed from cylinders, replace the caps.)

X. Clean work area; clean and put away all tools and equipment

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #3 — CUT MILD STEEL AT A 90-DEGREE ANGLE, STOP, AND RESTART THE CUT

I. Equipment and materials

- A. Oxyacetylene cutting outfit with tip assembly
- B. Mild steel plate, approximately ¼"×4"×8"
- C. Soapstone with a sharp point or edge
- D. Straightedge
- E. Welding gloves
- F. Welding goggles
- G. Pliers
- H. Coveralls or protective clothing free of oil and grease
- I. Flint lighter
- J. Welding or cutting table
- K. Slag box
- L. Can of water
- M. Cutting tip
- N. Foam or multipurpose dry-chemical fire extinguisher
- O. Tip cleaners

II. Procedure

(NOTE: Follow procedure in Job Sheet #2, steps A through O, to turn on equipment.)

- A. Make a 90-degree cut
  1. Mark four parallel lines 2 inches apart on plate to be cut
  2. Adjust oxygen regulator
  3. Adjust acetylene regulator
  4. Place plate to be cut over slag box

JOB SHEET #3

5. Clean tip

   (NOTE: Clean tip before lighting torch and as often as needed.)

6. Light torch with flint lighter
7. Adjust to neutral flame
8. Place hoses behind you
9. Assume comfortable position
10. Maneuver torch as required

    (NOTE: Sometimes you must use both hands to hold torch steady for a straight cut.)

11. Hold preheat flame with tip of inner cone 1/16 to 1/8 inch above top of plate at right edge until red spot appears

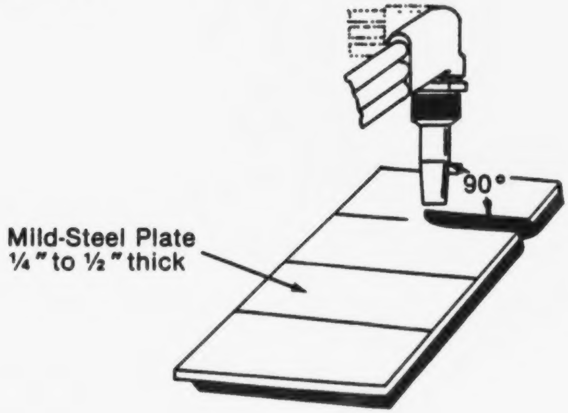
    CAUTION

    Burning metal flames and sometimes sparks, creating the danger of burns.

12. Depress oxygen cutting lever and move from right to left across the plate (Figure 20)

    (NOTE: Left-handed operators move from left to right.)

FIGURE 20



JOB SHEET #3

   13. Hold tip at right angle to work, while cutting with inner cone approximately $^{1}/_{16}$ inch above work
   14. Make 90-degree cuts until you have developed the proper procedure
   15. Cool metal by placing in can of water with the aid of pliers

B. Restart a cut

   1. Release oxygen cutting lever
   2. Preheat only the edge where cutting action was stopped
   3. Depress oxygen cutting lever slowly and continue cut

      (NOTE: Follow procedure in Job Sheet #2, steps P through W, to turn off equipment.)

C. Clean work area; clean and put away all tools and equipment

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #4 — CUT ROUND STOCK

I. Equipment and materials

A. Oxyacetylene cutting outfit with tip assembly

B. Pieces of reinforcing bar, ½-inch, ⅝-inch, ¾-inch, or 1-inch

C. Soapstone with sharp point or edge

D. Tape

E. Welding gloves

F. Welding goggles

G. Pliers

H. Coveralls or protective clothing free from oil and grease

I. Flint lighter

J. Welding or cutting table

K. Slag box

L. Can of water

M. Cutting tip

N. Foam or multipurpose dry-chemical fire extinguisher

O. Tip cleaners

II. Procedure

(NOTE: Follow procedure in Job Sheet #2, steps A through O, to turn on equipment.)

A. Mark reinforcing bar at desired length

B. Adjust oxygen and acetylene regulators

C. Place bar to be cut over slag box

D. Clean tip

(NOTE: Clean tip before lighting torch and as often as needed.)

JOB SHEET #4

E. Light torch with flint lighter

F. Adjust to neutral flame

G. Place hoses behind you

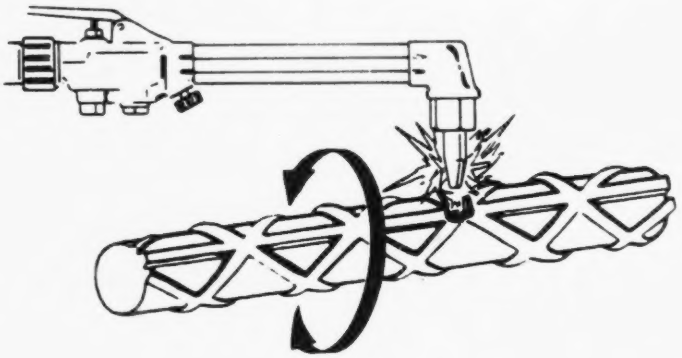
H. Assume comfortable position

I. Maneuver torch as required

J. Hold preheat flame with tip of inner cone $^{1}/_{16}$ to $^{1}/_{8}$ inch above edge of reinforcing bar until is becomes red

K. Depress cutting lever, and rotate torch in direction of travel until rod is cut (Figure 21)

FIGURE 21



L. Hold tip at right angle to work, while cutting with inner cone approximately $^{1}/_{16}$ inch above work

M. Cool metal by placing in can of water with the aid of pliers

N. Repeat procedure for each bar or rod

(NOTE: Follow procedure in Job Sheet #2, steps P through W, to turn off equipment.)

O. Clean work area; clean and put away all tools and equipment

OXYACETYLENE CUTTING
UNIT III

JOB SHEET #5 — CUT CABLE

I. Equipment and materials

A. Oxyacetylene cutting outfit with tip assembly

B. Cutting tip

C. Flint lighter

D. Piece of cable

E. Soapstone with sharp point or edge

F. Welding gloves

G. Welding goggles

H. Can of water

I. Foam or multipurpose dry-chemical fire extinguisher

J. Coveralls or protective clothing free from oil and grease

K. Tip cleaners

II. Procedure

(NOTE: Follow procedure in Job Sheet #2, steps A through O, to turn on equipment.)

A. Place fire extinguisher near work area

B. Determine where cable is to be cut; mark with soapstone

C. Adjust oxygen and acetylene regulators

D. Clean tip

(NOTE: Clean tip before lighting torch and as often as needed.)

E. Light torch with flint lighter

F. Adjust to neutral flame

G. Place hoses behind you

H. Assume comfortable position

JOB SHEET #5

I. Maneuver torch as required

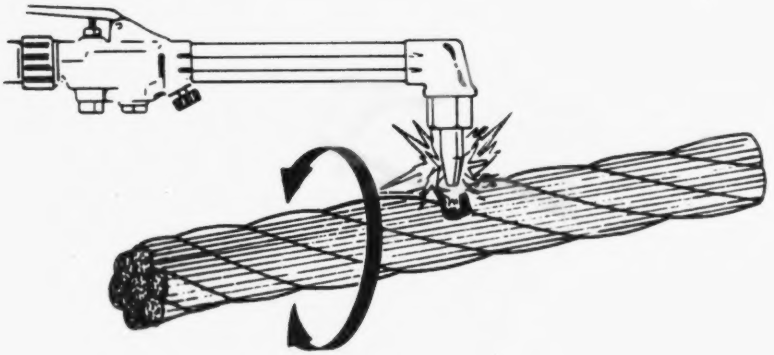
CAUTION

If there is tension on the cable, take care to avoid flying loose ends when the cable is cut. These ends can be very dangerous.

J. Hold preheat flame with tip of inner cone 1/16 to 1/8 inch above edge of cable until it becomes red

K. Depress cutting lever, and rotate torch in direction of travel until cable is cut (Figure 22)

FIGURE 22



L. Hold tip at right angle to work while cutting with inner cone approximately 1/16 inch above work

M. Cool metal by pouring water over hot ends

N. Repeat procedure for each cut

(NOTE: This is a very good method to use on all types of cable as it is quick and easy and will weld the ends, thus reducing strain on the seizing and preventing raveling. Follow procedure in Job Sheet #2, steps O through W, to turn off equipment.)

O. Clean work area; clean and put away all tools and equipment

OXYACETYLENE CUTTING
UNIT III

TEST

NAME ______________________________ SCORE ______________

1. Match terms associated with oxyacetylene cutting to their correct definitions. Write the correct numbers in the blanks.

_____a. Colorless, gaseous hydrocarbon used in cutting and welding

_____b. Element that is normally a colorless, odorless, and tasteless gas; used in combination with other substances in cutting and welding

_____c. Flame cutting of metal in which the preheating of the metal is accomplished with a flame produced by an oxyacetylene torch

_____d. To remove any foreign material from a system or component by flushing with the gas used in that system

_____e. Pounds per square inch

_____f. Capable of burning

_____g. Poisonous

_____h. Striker used to ignite torch

_____i. Metal container with a layer of water or sand to catch hot material

_____j. Metal that melts away during the oxyacetylene cutting process

_____k. Firmly binding cable with soft iron wire

1. Toxic
2. Purge
3. Oxygen
4. Combustible
5. Oxyacetylene cutting
6. psi
7. Acetylene
8. Seizing
9. Flint lighter
10. Slag box
11. Slag

2. State color codes for oxygen and acetylene.

a. Oxygen — ______________________________

b. Acetylene — ______________________________

TEST

3. Arrange in order stages in the oxyacetylene cutting process. Write a "1" before the first step, a "2" before the second step, and so on.

______a. Mixture burns at several orifices (preheat orifices) in torch tip

______b. Oxygen jet quickly oxidizes the heated base metal and blows it away

______c. Separate, flexible hoses carry gases to torch

______d. Flame heats base metal to a dull, cherry red

______e. Pressure-regulated acetylene and pressure-regulated compressed oxygen are supplied from two cylinders

______f. Removal of material leaves a cut in the metal

______g. Operator ignites acetylene gas with spark from flint lighter

______h. Operator presses oxygen lever, and jet of oxygen rushes out of cutting orifice

______i. Operator opens oxygen torch valve, and gases are mixed inside torch

TEST

4. Identify the parts of an oxyacetylene cutting outfit. Write the correct numbers in the blanks.

______a. Oxygen hose

______b. Oxygen cylinder valve

______c. Acetylene hose

______d. Acetylene cylinder cap

______e. Welding gloves

______f. Oxygen cylinder

______g. Acetylene cylinder

______h. Acetylene regulator

______i. Acetylene pressure-regulating screw

______j. Flint lighters

______k. Oxygen cylinder cap

______l. Safety chain

______m. Welding goggles

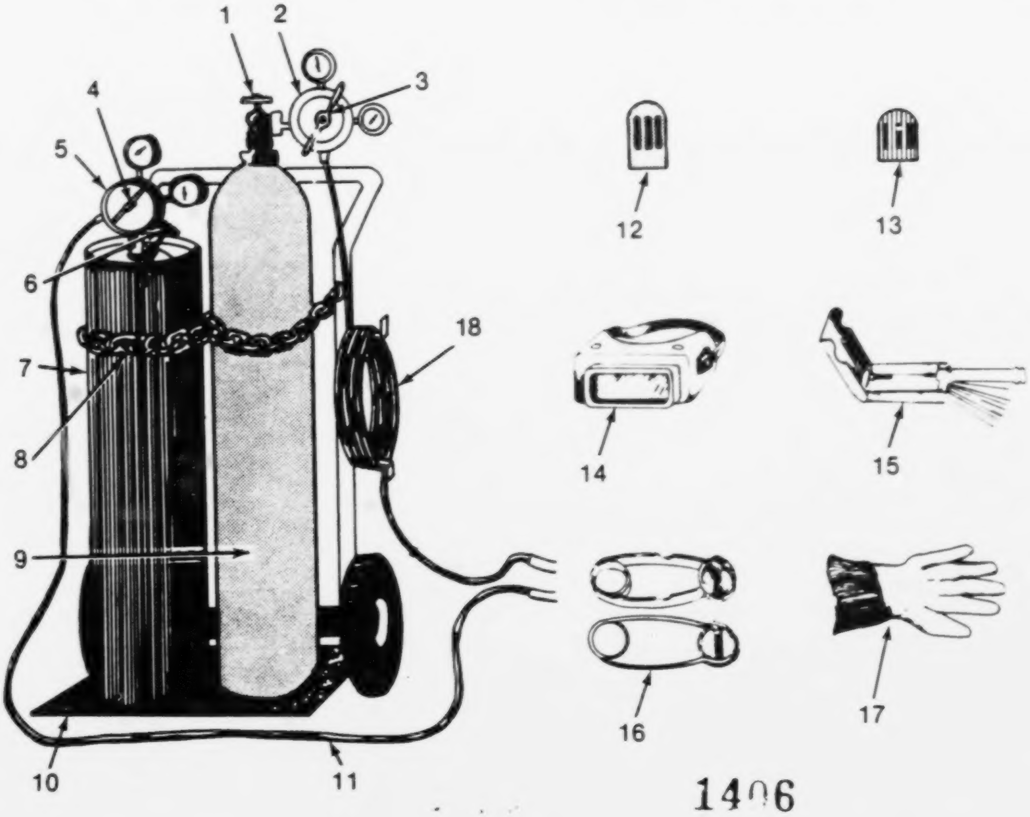
______n. Acetylene cylinder valve

______o. Oxygen pressure-regulating screw

______p. Tip cleaners

______q. Oxygen regulator

______r. Cylinder truck



TEST

5. Identify the parts of a torch body and cutting attachment. Write the correct numbers in the blanks.

______a. Acetylene fitting (grooved nut, left-hand threads)

______b. Cutting orifice

______c. Oxygen fitting (right-hand threads)

______d. Tip nut

______e. Oxygen preheat valve

______f. Preheat orifices

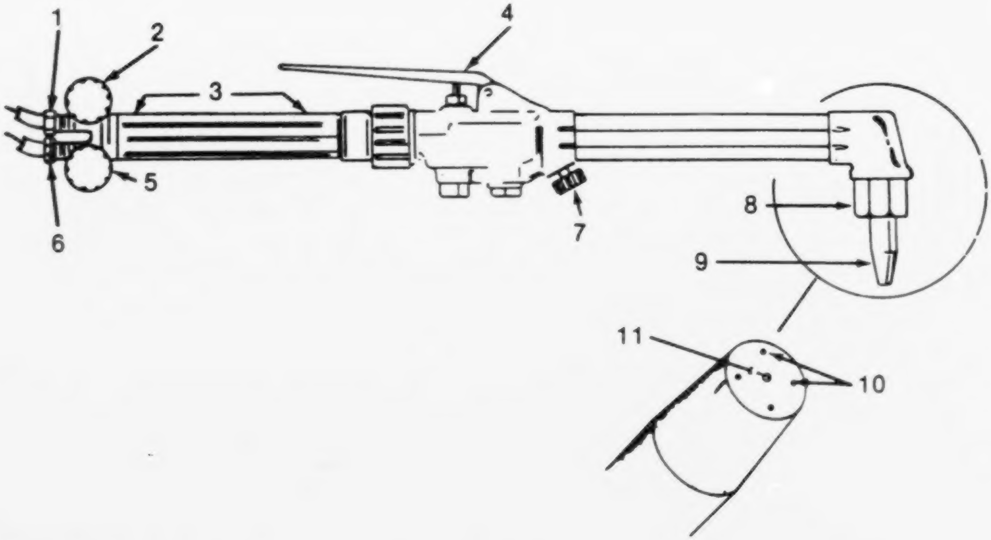
______g. Oxygen torch valve

______h. Tip

______i. Oxygen cutting lever

______j. Torch body

______k. Acetylene torch valve



6. State twelve safety rules for working with oxyacetylene equipment.

a. ____

b. ____

c. ____

d. ____

TEST

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

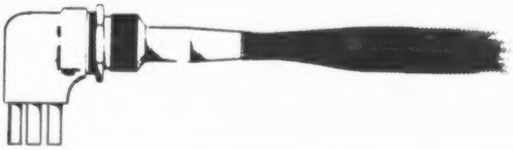
j. ______________________________

k. ______________________________

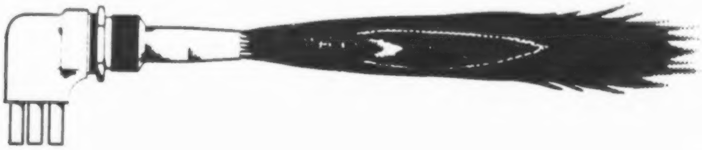
l. ______________________________

7. Identify the following types of oxyacetylene cutting flames. Write the correct names in the blanks.

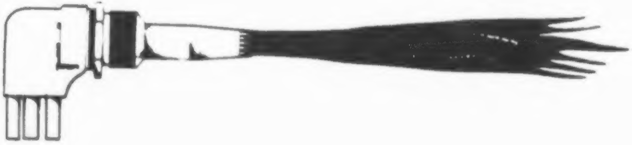
Neutral flame **Oxidizing flame** **Carburizing flame**



a. ______________________________



b. ______________________________



c. ______________________________

TEST

8. Distinguish between flashback and backfire. Write an "F" in the blank before flashback and a "B" in the blank before backfire.

_____a. Flame burns momentarily back into tip; then a loud snap or pop is emitted from the torch and the flame either goes out or continues to burn in a normal manner

_____b. Flame disappears inside torch body; at the same time, a squealing noise occurs and smoke and/or sparks are emitted from the torch tip

9. Arrange in order steps to follow in case of flashback. Write a "1" before the first step, a "2" before the second step, and so on.

_____a. Light torch

_____b. Release oxygen pressure-regulating screw

_____c. Reset regulator pressures

_____d. Close oxygen torch valve

_____e. Close oxygen preheat valve

_____f. Release acetylene pressure-regulating screw

_____g. Close acetylene torch valve

_____h. Examine acetylene unit

10. Select from the following list causes of backfire. Write an "X" in the blank before each correct answer.

_____a. Too much oxygen

_____b. Not enough acetylene or oxygen pressure for the tip size used

_____c. Too much acetylene

_____d. Loose cutting tip

_____e. Overheating of cutting tip

_____f. Bad O-ring in torch body

_____g. Dirty tip

TEST

11. Match common cutting-torch tips to their correct uses. Write the correct numbers in the blanks.

______a. Machine cutting 45-degree bevels or hand cutting rivet heads

______b. Cast-iron cutting and preparing welding Vs

______c. Splitting angle iron, trimming plate, and cutting sheet metal

______d. General cutting; cutting cast iron and stainless steel

______e. Grooving, gouging, or removing imperfect welds

______f. Hand cutting rivet heads; machine cutting 30-degree bevels

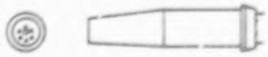
______g. Straight-line or circular cutting of clean plate

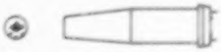
______h. Cutting rusty or painted surfaces

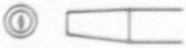
______i. Grooving, flame machining, gouging, and removing imperfect welds

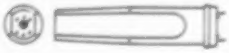
______j. Removing rivet heads (washing)

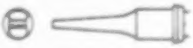
______k. Straight-line or shape cutting of clean plate

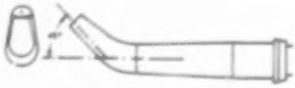
1. 

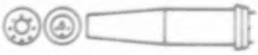
2. 

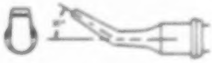
3. 

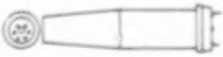
4. 

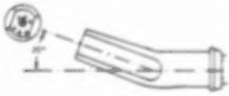
5. 

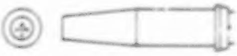
6. 

7. 

8. 

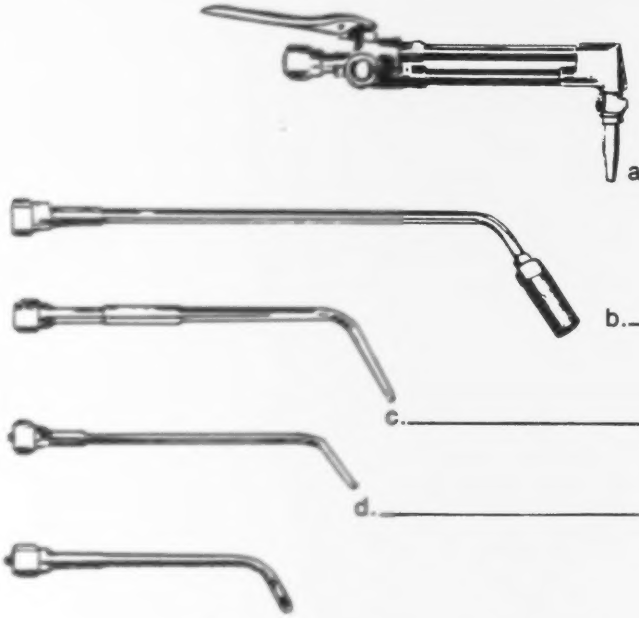
9. 

10. 

11. 

TEST

12. Identify a multiflame heating nozzle (rosebud) and tip from the illustrations below. Write an "X" in the blank beside the correct illustration.



a. ____________________

b. ____________________

c. ____________________

d. ____________________

e. ____________________

13. Describe uses of a multiflame heating nozzle (rosebud).

____

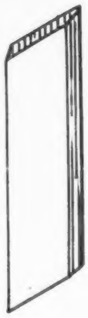
____

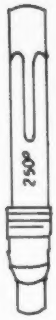
____

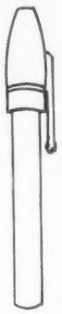
____

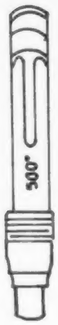
TEST

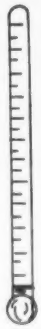
14. Identify temperature sticks (temp-sticks) in the illustrations below by placing an "X" in the correct blanks.











a. __________ b. __________ c. __________ d. __________ e. __________

15. Describe the selection and use of temperature sticks (temp-sticks).

    a. Selection

        1) ______________________________

        2) ______________________________

    b. Use

        1) ______________________________

        2) ______________________________

(NOTE: Test question 14 lists the job sheets. They are an important part of this test. If they have not been completed, check with your instructor.)

16. Demonstrate the ability to

    a. Set up equipment for oxyacetylene cutting.

    b. Turn on, light, adjust to a neutral flame, and turn off oxyacetylene cutting equipment.

    c. Cut mild steel at a 90-degree angle, stop, and restart the cut.

    d. Cut round stock.

    e. Cut cable.

OXYACETYLENE CUTTING
UNIT III

ANSWERS TO TEST

1. a. 7
   b. 3
   c. 5
   d. 2
   e. 6
   f. 4
   g. 1
   h. 9
   i. 10
   j. 11
   k. 8

2. a. Green
   b. Red

3. a. 5
   b. 8
   c. 2
   d. 6
   e. 1
   f. 9
   g. 3
   h. 7
   i. 4

4. a. 18
   b. 1
   c. 11
   d. 13
   e. 17
   f. 9
   g. 7
   h. 5
   i. 4
   j. 16
   k. 12
   l. 8
   m. 14
   n. 6
   o. 3
   p. 15
   q. 2
   r. 10

5. a. 6
   b. 11
   c. 1
   d. 8
   e. 7
   f. 10
   g. 2
   h. 9
   i. 4
   j. 3
   k. 5

6. Answer should include any twelve of the following

   a. Make sure that either a foam or a multipurpose dry-chemical fire extinguisher is readily available and in working condition
   b. Wear welding goggles, gloves, and protective clothing
   c. Wear gloves to handle hot metal
   d. Use open torch only in a well-ventilated place
   e. Avoid breathing toxic fumes
   f. Do not leave a burning torch unattended
   g. Secure cylinders in a safe place
   h. Cut or weld at least 5 feet from cylinders
   i. Always use regulators; do not use oxygen or acetylene directly from cylinders
   j. Use flint lighters, *not matches*, for lighting torch
   k. Use hoses designated for oxygen and acetylene only
   l. Do not use oil on regulators, torches, fittings, or any equipment surface that may come in contact with oxygen
   m. Do not use compressed oxygen to clean off clothing

ANSWERS TO TEST

n. Do not breathe compressed oxygen directly from cylinder or hose
o. Use soapsuds and paintbrush to test connections for leaks
p. Do not use acetylene at pressures higher than 15 pounds per square inch
q. Do not cut or weld directly on gravel or concrete
r. Keep heat, flames, and sparks away from combustibles
s. Do not cut or weld on containers that have been used to store combustible materials unless containers have been properly cleaned and purged

7. a. Oxidizing flame
   b. Carburizing flame
   c. Neutral flame

8. a. B
   b. F

9. a. 8
   b. 4
   c. 7
   d. 2
   e. 1
   f. 5
   g. 3
   h. 6

10. b, d, e, f, g

11. a. 6
    b. 1
    c. 5
    d. 9
    e. 4
    f. 8
    g. 3
    h. 7
    i. 10
    j. 2
    k. 11

12. b

13. Description should include the following — Used to heat parts or metals before fitting them together; also used to preheat metal before welding

14. b, d

15. a. Selection
    1. Temperature sticks come in a wide variety for different temperatures
    2. Proper temperature stick is determined by the type of metal or part being used or by the specifications

ANSWERS TO TEST

- b. Use
    1. Used during the heating process
    2. Mark dissipates when the metal or part has reached the proper temperature

16. Performance skills evaluated to the satisfaction of the instructor